

USABILITY AND USER DOCUMENTATION IN A HEALTH INFORMATION SYSTEM

The case of District Health Information System 2 in Malawi



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Abstract

This thesis offers a usability and user documentation review of a Health Information System, District Health Information System 2 (DHIS 2). To reach the Millennium Development Goals (MDGs) for health improvement set by United Nations, it is important to develop instruments for monitoring health status. To gain full benefit from Information Systems, these instruments must be fully implemented and customized for the users and their needs.

The thesis includes two studies on the real world value of user documentation in the health management information system DHIS 2, with a particular focus on its implementation in Malawi. DHIS 2 is a software used for the collection, validation, analysis and presentation of aggregate statistical data. This study addresses the current usability of DHIS 2 and the value of its user documentation. It reviews literature about software usability and user documentation. It covers various types of documentation and analyzes how the documentation of DHIS 2 fits in with this.

The studies apply both quantitative and qualitative methods. One study is a questionnaire with qualitative and quantitative questions (mixed methods research) that surveys workers in Malawi who enter and analyze data, using DHIS 2. The study participants are Malawian Health Management Information System officers from the 29 administrative districts. The second study is a non-participant observation study of students at University of Oslo using DHIS 2 for the first time.

Important positive findings of the study were a reported high level of satisfaction with the use of DHIS 2. All the surveyed participants would recommend the use of DHIS 2 to other countries. The data indicate that the software's error messages are particularly useful. The user manual is also highly valued by a portion of the users. Among the more concerning findings was that one third of the participants reported not to be aware of the user manual. Also, the dominant problem-solving approach was contacting others by external communication options although an integrated functionality is offered within the DHIS 2 software.

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List of abbreviations and acronyms

DHIS: District Health Information System

DHIS 2: District Health Information System 2

HIS: Health Information System

HISP: Health Information System Programme

HMIS: Health Management Information System

HS: Health System

IS : Information SystemMDGs : Millennium Development Goals

MoH : Ministry of Health

Health Center: A building or institution where medical services are offered or a group of doctors practices ("health center. (n.d.). Dictionary.com's 21st Century Lexicon.," 2014).

NGO : Non-Governmental Organization

Outreach clinic: A clinic run by a hospital doctor who makes regular visits to a primary care setting to see patients who would otherwise be referred as hospital outpatients ("outreach clinic - definition of

outreach clinic in the Medical dictionary - by the Free Online Medical Dictionary, Thesaurus and Encyclopedia.,” n.d.).

UI: User Interface

UiO: University of Oslo

CHAPTER 1 INTRODUCTION

1.1 Study background

Malawi has undergone a restructure of their Health Information Systems with the help of, among others, the University of Oslo (UiO). The goal of the restructure was to promote information based decision making in the health sector, as well as measuring progress on achieving the United Nations Millennium Development Goals (MDGs) no one, four, five and six, which are related to health issues.

The MDGs are a set of eight goals that have been agreed upon by most development organizations to work towards. The no. 1 goal is to eradicate extreme poverty and hunger. The health related goals include reducing child mortality, improving maternal health and combating HIV/AIDS, malaria and other diseases.



Figure 1 - The MDGs for 2015

As a central part of the Malawian Health System restructure, Malawi implemented a software called District Health Information System 2 (DHIS 2). DHIS 2 used to store and analyze quantitative health information. It can generate reports, statistics and various information from a set of data. The aim of DHIS 2 is to provide better basis for evidence-based decision-making in the health sector. It is also used to measure progress on the United Nation MDGs. Malawi has implemented DHIS 2 in all 29

districts and managed to get good coverage on the core data sets. However, there is still a long way to go to get full value of health information and the Information System.

University of Oslo (UiO) has taken a leading role in developing and implementing DHIS 2 in more than 40 countries around the world. DHIS 2 has around 10 000 users. The Health Information System Programme (HISP), which UiO coordinates, continuously supports, evolves and expands DHIS 2 to improve the quality and use of Health Information.

There have previously been two master assignments with similar research objectives to this thesis. One was about training DHIS 2 workers in Kerala, India (Johansen, 2012). It relates to this thesis because it explores training of DHIS 2 users, and one of the major reasons to focus on usability in DHIS 2 is to make training less costly. It differs from this thesis because it is more about evaluating training sessions, exploring motivations and investigating how cultural artifacts affect training. It was not about usability of the software itself.

The other study was also conducted in Kerala, India. It explored user acceptance of DHIS 2. It found that usefulness is an important motivation (Joshi, 2009). It did not focus on user documentation or usability, so it does not have much in common with this thesis.

Usability and user documentation are important aspects in determining how efficiently DHIS 2 is used and how costly it is to train users to reach an acceptable level of expertise. Especially in countries with limited resources and tight constraints it is important to get the most benefit from any governmental investment. Good usability can cut costs in training and have the system operate more efficiently.

The study falls into a body of research on the importance of manuals, their quality and their use.

1.2 Research questions / objectives

The research questions of this thesis focus on the usability, user documentation and satisfaction of DHIS 2. More specifically:

1. How is the usability of DHIS 2 for users in Malawi?
2. How are the user manuals of DHIS 2 experienced by users in Malawi?
3. How is the overall satisfaction with DHIS 2 among users in Malawi?
4. How is the usability of DHIS 2 for novice users of the system?

1.3 Motivation

Human health in developing countries and improving it through large international initiatives is a very inspiring issue. Unites Nations' millennium development goals are addressing this and action is demanded to improve health and reduce child mortality. The goals cannot be reached without tools to help define needs and measure progression and improvement. DHIS 2 is an important premise in the countries that have implemented it, and successful implementation relies upon, among other issues, good usability of the software. DHIS 2 is a software that directly aims to improve decision making in the health sector of more than 40 countries and I consider it of great importance that its 10 000 users are capable of contributing to this. It is inspiring to work with project, which in the end may have such a substantial impact.

It is further a great inspiration that the Norwegian government and the University of Oslo in particular, have taken a key role in the developing software for the success of restructuring the health systems in developing countries. UiO coordinates and manages the Health Information Systems Programme (HISP) and students such as myself, are a resource to accomplish research that can improve and stimulate these initiatives.

It is a motivation factor for me to learn about developing countries and participate in the long-term process of improving health status for large and troubled populations. I have a special interest in the health sector as both my mother and father are employed in this sector. I have also previously worked with IT in the Norwegian health sector and I find it interesting to study how the health sector is organized and can be improved at a system level. This requires appropriate surveying tools for decision making in all countries.

I have attended relevant courses both in conducting my bachelor's degree at Oslo and Akershus University College for applied sciences and I have completed IT Infrastructure courses at the University of Oslo along with a course on pedagogic instructions. During my bachelor period, I also completed relevant courses in Human Computer Interaction and learned about Usability principles. Usability has all along been my focus and can now be applied on an issue with great impact on people's lives. Usability of the software can potentially matter for the quality and quantity of input in the database, analysis of health information. The usability of DHIS 2 certainly affects the people who work with the software every day and it can potentially also have a positive effect on the leadership in the health sector of entire countries.

1.4 Assumptions and limitations

I have chosen to focus exclusively on the parts of the DHIS 2 interface that deal directly with data entry or data report generation. The project does not delve into the complexities of management and leadership and is not considering the aspects of health system management as such. The scope is limited to the information system from a technology and user perspective. The issue of how the reports generated by Health Information System influences decision-making is hence not within the scope of the thesis.

1.5 Structure

This thesis is divided into the following chapters:

CHAPTER 1 - Outlines the background of the study, contains the research problem and the motivation of the study, contains acknowledgements and lists a set of assumptions.

CHAPTER 2 - Offers a broad overview of a Health Information System (HIS) and describes the history of DHIS 2 and the role of UiO. It supplies relevant information on Malawi, including the status of the Health Information System. Finally, it offers an introduction to the DHIS 2 software.

CHAPTER 3 - Gives an overview of the usability field and reviews some of the literature on user documentation and the use/usability of user documentation.

CHAPTER 4 - Briefly describes the three main research methodologies, provides in depth descriptions of the specific methods used in the studies, and chronicles the data collection. The methods are questionnaire, heuristic evaluation and non-participant observation using video.

CHAPTER 5 - Lists and analyzes the findings of the studies.

CHAPTER 6 - The chapter discusses the findings in the context of the literature reviewed earlier in the thesis.

CHAPTER 7 - This chapter contains conclusions and suggestions for further work.

CHAPTER 2 BACKGROUND ON DHIS AND THE CASE OF MALAWI

In this chapter, the aim is to explain the meaning of a health information system. Background, descriptions and explanations of the software District Health Information System will follow. Finally, it offers an overview of the country profile of Malawi.

2.1 Health Information System

The benefits of collecting and analyzing health data have been utilized by humans for at least the last several hundred years. An early example of how counting and registering deaths helped to find their cause was during a London Cholera epidemic in the mid-1800s. By registering the street addresses and counting victims, researchers found that mortality was higher in closer proximity to water pumps. The almost universal death registration in developed countries like England, Denmark and the Netherlands enabled the study of patterns of death and led to the creation of public health in the nineteenth century. Population-based surveys are now the predominant method of measuring public health (AbouZahr & Boerma, 2005).

2.1.1 Information system

A system can be defined as any *“collection of components that work together to achieve a common objective”* (Lippeveld, Sauerborn, & Bodart, 2000). There are systems everywhere around us. A few examples are computer systems, train systems, communication systems (e.g. phones), door systems and cooling systems. Depending on the granularity in which you look at it, systems always fit within an ecosystem of subsystems. For example, you can look at the human body as a system because it is a selection of components that work together to achieve a common objective. The subsystems may be the respiratory system, the muscle systems and the nervous system (e.g. brain). These subsystems consist of subsystems themselves that can extend to molecular levels.

Information can be defined as *“a meaningful collection of facts or data”* (Lippeveld et al., 2000). One definition of an Information System (IS) is *“the use of technology (manually or computer based) in a collective work activity, either as a means of work or of coordination and communication”* (Anja Mursu, Irmeli Minkkinen, 2007). A definition commonly used in industry is *“systems that provide information support to the decision making process at each level of an organization”* (Lippeveld et al., 2000). In other words, IS are systems that contain information that people need to make informed decisions, and that are meaningful to the people who use them.

2.1.2 Health System

In order to help understand the meaning of the term Health Information System (HIS), it is necessary to describe the meaning of Health System (HS). A comprehensive Health System offers integrated health services including curative care, rehabilitative care, disease prevention and health promotion services. A health system is the sum of all organizations, resources and institutions that primarily go toward improving health. Thus, one of the main functions of a health system is to offer care for the ill or disabled.

According to Lippeveld the *“ultimate goal of the Health System (HS) is to improve health status of the individuals in a population”* (Lippeveld, 2001). At least four factors determine health status: Biological assets, personal lifestyle, the environment and the health system. Health status is the overall health of a person and includes for example disease history, life expectancy, nutrition, environmental health hazards and personal lifestyle. Thus, *“health status”* includes more than the health system and the health system can only partly contribute to good health (Lippeveld, 2001).

A Health System is the sum of all resource, activities, institutions and organizations that contribute to improve the health status of a population (WHO, 2005). Institutions, like donor-funded organizations as for example the Red Cross are vital, but the ultimate responsibility for a country's health system lies with the country's government.

2.1.3 Health Information System

The previous sections explained Information Systems and Health Systems. This section will *“connect the dots”* and explain the term Health Information System (HIS). If we apply the previously discussed definition of an IS; *“systems that provide information support to the decision making process at each level of an organization”*, the organization in this case is the Health System and the information support consists of health data. There are many different terminologies for Health Information Systems that have the same meaning with only subtle differences. The term Health Management Information System (HMIS) has a managerial slant, Healthcare Information Technology (HCIT) has a technology slant and Health Information System can be interpreted as the umbrella term (Tan & Payton, 2010). Health Information Systems use routine health data as a basis for management (Lippeveld, 2001). A Health Information System has a strong bias towards quantitative data and does not contain qualitative health-care information for professionals, nor does it contain general health related knowledge (AbouZahr & Boerma, 2005).

Traditionally three concentration levels divide healthcare: Primary, secondary and tertiary. Primary level is where the first point of contact between the patient and the health system normally occurs

In Norway a general practitioner is a primary health care worker. Secondary and tertiary units give more specialized healthcare that primary healthcare workers refers patients to if needed. Examples of secondary healthcare can be specialists in smaller health units or in hospitals. Secondary and tertiary levels are also called referral levels (Lippeveld et al., 2000).

These concentration levels are organized as follows in the Malawian health system (Hamre, 2007):

“Primary level healthcare is delivered through health centers and outreach clinics.

Primary level care treats normal deceases, but mainly consists of preventive services or measures to promote health.

The secondary level provides services that back up those at the primary level.

Secondary level services are provided in Malawi by governmental district hospitals and Christian Health Association of Malawi hospitals and include surgical services, obstetric emergencies and general medical care for common acute conditions

Tertiary level provides similar services as secondary level in addition to a smaller range of special and complicated surgical interventions.”

In order to orchestrate a well-functioning health system there is a requirement for extensive information flow. Figure 2 illustrates the information flow in a Health System. The levels illustrated are not to be confused with the levels of service delivery discussed above. The figure illustrates the ideal flow of information in a general Health System.

In this context, a community is the geographical area that a health facility serves. It includes everything within that area; for example churches, houses, large or small populations, terrain types, religion and cultural attributes. In addition, factors that influence health, like sanitation and access to clean water are constituents of the community. Facility level refers to the health facilities. They report on how many people work there, how many doctors, how qualified they are and what can they can treat. Health staff in the facilities makes case-by-case decisions on treatments and what medication should be prescribed. District level refers to administrative units that make more strategic decisions. Provinces are larger administrative districts.

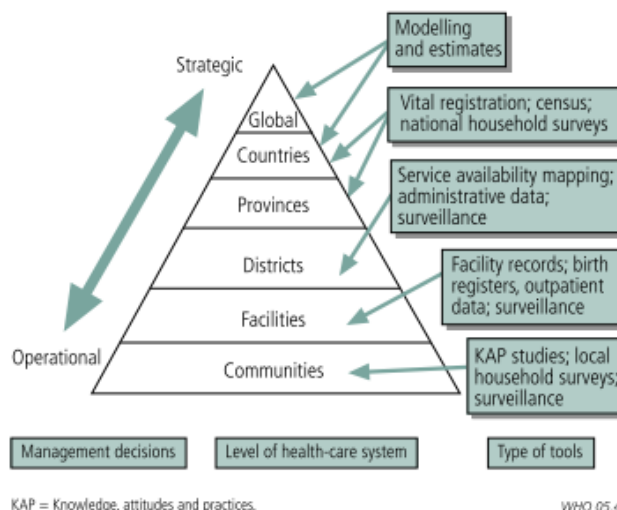


Figure 2 Organizational model of the health services (AbouZahr & Boerma, 2005)

Every level of a Health System filters gross information differently. Health workers at the individual level need information for effective clinical management. The community needs data for assessing how well services meet the needs and demands of the communities. The district level needs information for decisions regarding effective functioning of the facilities and the health system in a district as a whole. Higher levels need information for resource allocation and strategic policy planning (AbouZahr & Boerma, 2005).

Generally the lower levels need specific and detailed data for delivering healthcare to individuals, while higher levels need more general data for policy planning. A common problem in health information systems is that the lower levels are required to report large quantities of specific raw data. This can result in information overload at the higher levels, which in turn means that the essential information disappears in the mass. Ideally, health data each level in the hierarchy should filter and generalize the data relevant for the level above.

Computerized software applications for database management and data analysis can greatly enhance the efficiency of health information systems. Computerized software is an important tool to increase the use of relevant information for decision-making. In order for countries to utilize health information system software in a productive manner, the user interface of the software should have an intuitive appearance, which lets users focus their energy on work tasks instead of dealing with complicated or inefficient user interfaces.

2.2 District Health Information System

The District Health Information System (DHIS) software is a database tool for collection, management, validation, analysis and presentation of aggregate statistical data. DHIS 2 is designed to address both local and national needs for evidence based decision making (Manya & Braa, 2012). The software is an essential element of a Health Information System (HIS), but HIS can also be a wider term, which includes all the paper based and computer based tools, organizational and human elements that make the collection and utilization of health data possible.

The original vision of DHIS was as follows: *“To support the development of an excellent and sustainable Health Information System that enables all health workers to use their own information to improve coverage and quality of health care within our communities”* (Heywood & Rohde, 2002).

UiO plays a key role in developing the software and helps with generating funding. They are supervising doctoral and masters research students and conduct different educational programs to bring the project forward (Braa, Monteiro, & Sahay, 2004).

The following section contains background information that explains the development of DHIS further, then an in depth description of the second version of the system termed the District Health Information System 2 (DHIS 2).

2.2.1 Millennium Development goals for health improvement

In September 2000, world leaders came together at the United Nations (UN) headquarters in New York to set policy for reaching a set of targets that were to become the Millennium Development Goals (MDGs). At this summit, the participating nations committed to a partnership (United Nations Millennium declaration).

The major themes of these goals are to reduce the amount of poverty, disease and hunger, affecting billions of people (“United Nations Millennium Development Goals,” n.d.). The goals are:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender inequality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other deceases
7. Ensure environmental sustainability
8. Global partnership for development

Four of these goals (number 1, 4, 5 and 6) are health related. All of the goals listed above have a set of defined milestones with a deadline in the year 2015. In total, there are 21 targets and many of them are currently met (“United Nations Millennium Development Goals,” n.d.).

A requirement for meeting the MDGs is that it is possible to measure health status. This has led to an increased focus on Health Information Systems (HIS) by governments and donor organizations.

2.2.2 The origin of District Health Information System

The District Health Information System is a software developed by the Health Information System Programme (HISP). HISP is an international network initiated, managed and coordinated by the University of Oslo (“HISP - Department of Informatics,” 2014). HISP is using a participatory approach to support, implement and design Health Information Systems in developing countries. An inspiration to HISP was Scandinavian action research in the 1970s and 80s. The research designs of that era focused on empowering workers affected or threatened by new technologies. Later projects focused on involving workers in a participatory design of technologies for the workplaces. HISP can be seen as a continuation of Scandinavian action research tradition because it is using Information Systems to empower disadvantaged regions, countries and communities. HISP approaches development by prototyping rapidly and involving all organizational layers off the health hierarchy in integrating the Information System (Braa & Sahay, 2013).

HISP cooperates with departments of health, Nongovernmental Organizations (NGOs), donors and global health agencies. The mission statement of HISP is:

“HISP adopts a broad based, developmental approach to capacity building and support of communities, healthcare workers and decision makers for improving Health Information Systems.

In partnership with ministries of health, universities, NGOs and private companies, we support integration of information systems through open standards and data exchange mechanisms.

Focusing on local solutions for developing country contexts, we subscribe to the Free and Open Source philosophy of sharing our products such as training materials and software solutions. We promote access to and use of information for action.

(HISP, n.d.)”

When the South African apartheid regime ended in 1994, it was times of drastic changes in the South African society. The authorities needed to adapt to the fact that they were a democratic

country with equal rights for a large population. One of the areas where they had to perform an extensive restructuring was the health sector. A subcommittee of HISP suggested piloting a district based health information system. This subcommittee had two members of the HISP on its board. The Norwegian Agency of Development and Aid (NORAD) agreed to help fund the project, and this was the very beginning of the District Health Information System and development of the software to tool it (Braa et al., 2004).

Large amounts of fragmentation and quickly changing organizations were a huge problem in South Africa during the apartheid rule (1948 - 1993). For example, during this time and until May 1994 there were 14 departments of health at the central level. There was one general health department, one department each for white people, colored people and Asians and there were 10 for blacks, homelands and self-governing states (Braa & Sahay, 2013). This led to a lot of duplicate and overlapping data collection. There were multiple different standards in use as each province developed their own.

The development of the District Health Information System (DHIS) software was important in the strategy to decentralize and integrate South Africa's Health Services. The focus when developing DHIS was that it needed to have a flexible data structure to support a fast changing organization environment and to integrate new elements that previously had been fragmented. It had to be easy to add, change or remove data elements, add or remove districts and change organizational boundaries (Braa & Sahay, 2013).

2.2.3 The Malawian Health System restructure

In Malawi, the Health System restructure started in 1999. Before this, Malawi did not have an effective Health Information System (HIS). The health system rarely used gathered health information for decision-making because it was of poor quality and data gathering was uncoordinated. Different programs gathered data for their own local use and there was duplication of data because of lack of communication and cooperation between the different programs. The information they collected was not very useful and the districts did not prioritize information gathering (Chaulagai et al., 2005).

The design of the health system restructure started as an analysis of the current systems' strengths and weaknesses, carried out in September 1999. The results of the analysis were presented to the stakeholders at a workshop. The participants of the workshop established the need for a restructure of the health information system. The first part of the restructure was to identify a set of minimum indicators and datasets. The process started with the creation of a 5-year strategy. The goal of this

strategy was strengthening the health information system capacity to feed information to the users at community, health facility, district and national levels. This led to the revision of tools for data collection, processing and reporting. The revised tools went through a testing period of 18 months. The pilot started with three facilities and over time expanded to a whole district and a central hospital (Chaulagai et al., 2005). The health information system used to be all paper based but a computer based interfaced had now replaced it and DHIS was being used for data processing. A computer-based system was advantageous because it made it easier to distribute timely reports to the people who needed them and manually transcribing reports is a slow process prone to error.

In December 2010, the Malawian Ministry of Health (MoH) started the implementation of DHIS 2 in Malawi. The University of Oslo initially funded the pilot. It started with 6-month period of system- and database building in five districts. The plan was to have functionally implemented DHIS 2 in all 29 districts by the third year (2013).

2.2.4 Development of DHIS

DHIS was developed as an “*Open source*” Software, but it was developed using MS Access, which is part of the Microsoft Office suite of applications. Microsoft Office was the *de facto* standard for potential users in South Africa and hence it was at the time practical to use it. This meant that DHIS required the Microsoft Windows operating system and Microsoft Office in order to run (Braa & Sahay, 2013).

“*Open source*”, or free software, has its source code available so anyone can view it, modify it, or do what they want with it. In this context, free software does not refer to free as in not costing money, but free as in freedom. A software systems “*source code*” is the code that the computer reads when it runs the software, or the code programmers write when they develop the software. Examples of closed vs. open source software are Windows and Linux, respectively. In Windows, Microsoft has the exclusive rights to update or modify the operating system. In contrast, the Linux system makes the source code public. This has stimulated many companies to make their own versions of Linux and customizing it to their needs. Android is an example of a Linux based operating system. Microsoft Windows is limited to the versions that Microsoft releases, as no one else can view or modify the source code.

During the first prototype in 1997/1998, several objectives were translated into specific inscriptions (Braa & Sahay, 2013) for the software. These were:

- To allow users to add, modify and delete local data elements to support the hierarchy of essential datasets

- It should be designed in a way to support the decentralized analysis, capture and use of data having the facility staff responsible for data capture, data analysis and output
- The software should support the decentralization in the health system, in particular having the facility staff who collect the data capture it in the database, do data checks, initial processing and output
- The software should be easy to adapt to new local settings
- The software should rely as much as possible on powerful tools already available in Microsoft Office
- The software should be based on open source principles

The process of developing DHIS was a user centric process where any interested users could have full access to the development team of two developers in order to reach a shared understanding of the system between the users and the developers. Ten HISP workers functioned as mediators between developers and users. This was only possible with a limited amount of users because of time consuming communication between the different users and the developers (Braa & Sahay, 2013).

DHIS 2 was first piloted in March 1998. Within the next 4 to 8 months, the DHIS prototype went through a series of rapid cycles. The process of developing DHIS was gradual and based on communication between developers and users. The software was updated frequently, sometimes even weekly, or daily. The specifications were flexible and based on user needs, rather than fully specified and set in stone. The software was modular, so new modules could be added or removed as needed. The software could gradually expand in scope based on the user demands and experience. This approach was chosen because attempts of implementing a fully specified HIS had often failed (Braa & Sahay, 2013).

By the year 2000, DHIS (v 1.3) was well adapted and specified for the needs of South Africa. However, as the DHIS project was expanded to incorporate Mozambique, India, Vietnam and Cuba, problems arose because the current version was difficult to adapt to the needs of different countries. This sparked the development of a new and internationalized version of DHIS (v 1.4). Version 1.4 was developed using the same Microsoft Access framework as had previously been used, which meant it required the MS Windows operating system and MS Office to run. Because of these shortcomings, a new version of the software was required. The new version was to become DHIS 2. DHIS 2 had to be built from the ground up with a different set of tools that were generic and not restricted to certain software companies.

2.2.5 Development of DHIS 2

As described, the implications of DHIS requiring a Microsoft platform severely limited the accessibility. Thus DHIS 2 was developed using Java technologies, which is “Open source” software and can run on every operating system or web browser. JAVA is a web framework that allows any web browser to run applications developed within it. Because it was a JAVA project, DHIS 2 could then be deployed on a web server that supported JAVA servlets. This meant it could be accessed by any web browser over the Internet, as well as offline in an intranet setting (Manya & Braa, 2012). It was important to transfer DHIS to a JAVA setting because the threshold for when and where to use DHIS 2 would be lower when there was no need for dedicated hardware or software setups to run it. The Java framework was universal and also allowed it to integrate with mobile platforms.

UiO led the DHIS 2 development process. The process included developers in a number of the HISP countries in order to bring development closer to the context of use. Having developers spread over several countries proved to be challenging as communication had to happen in electronic media (mail, skype etc.) instead of face to face. There were also challenges associated with developing in the JAVA framework, which proved to be very different from MS Access. Developers had to retool the software in a different programming language with other capabilities and it was challenging to overcome these technological barriers (Braa & Sahay, 2013).

Developers from India, Vietnam, Tanzania, Ireland and Norway are currently working on the evolution of DHIS 2. As of October 2012, more than 30 countries in Africa, Asia and Latin America were using DHIS 2 as a part of their nationwide HIS (Team Dhis Documentation, 2014).

Sense making of health information requires clearly defined indicators. The World Health Organization (WHO) defines an indicator as “*variables that help to measure changes directly or indirectly*”. Indicators can put raw data in context and make them mean something. For example, instead of using raw data and state that “*140 health posts have electricity*”, an indicator would state, “*86% of all health posts have electricity*”. Calculating indicators requires a numerator and a denominator. An indicator is a counted number (numerator) compared to a total (denominator). DHIS 2 uses indicators for making sense of raw data.

2.2.6 Use of DHIS 2 at the primary level in the Health System

The primary level (health facilities) typically generates data from the communities. The staff do this by filling in paper reports on the activities at the facility. They then send the reports to the health

management units in the districts. Staff at the district offices, often the health management information system officers (described on page 55) enter the data from the reports into DHIS 2 and use them for analysis. There is not a major difference between which data elements and indicators different levels in the hierarchy uses.

Mostly third world countries use DHIS 2, and many of the health facilities do not have a computer or reliable access to power. This makes it difficult for facilities to make use of DHIS 2 data in their local planning. Some facilities actively use the paper reports for measuring their performance and accordingly adjusting their activities, but this is the exception rather than the rule (oral information from Jens Kaasbøll). A possibility for the facilities would be to use data from the reports to coordinate between facilities for better resource utilization. However, this requires meetings that are often costly and time consuming and hence not common.

With tablets getting less expensive, a feasible solution in the future would be to equip facilities with tablets they can use to browse DHIS 2 (oral information from Jens Kaasbøll). This could substitute submitting paper based reports, as the facilities could submit them electronically. An advantage tablets have over computers is portability and improved battery capacity. Tablets could also potentially increase the use of DHIS 2 for decision-making in the facilities as it provides a portal to the database. However, it requires internet connection, which may be limited at facility level.

2.2.7 The DHIS 2 application

The DHIS 2 application is as described earlier, a tool for data collection, validation, analysis and presentation of aggregate statistical data, tailored for health information management activities (Team Dhis Documentation, 2014). DHIS 2 consists of multiple different functionalities also known as modules. There are seven main modules. For example, there is a module for entering data into the database, called *“Data Entry”* and a module for validating the data, called *“Data Quality”*. Some modules have a number of sub modules. The *“Reports”* module has sub modules like *“Standard reports”*, *“Dataset reports”* and so on. There are multiple functionalities for data analysis. These are:

1. Dashboard
2. Standard reports
3. Dataset reports
4. Data Visualizer
5. Report tables
6. Organizational unit distribution reports
7. Reporting rate summary

8. Pivot Tables

The Dashboard module (Figure 3) is the first screen a user sees when logging in to DHIS 2. It is an overview and navigation tool located at the user's home page. The dashboard is user specific and the users can customize shortcuts to reports, report tables and map views.

The top menu serves as a navigation menu. It stays at the top of the screen, even when the screen scrolls down the page. The icon “DHIS 2” located at the left side of the top menu always links back to the dashboard. The “apps” and “profile” icons are dropdown menus with links that point to modules in DHIS 2. The top menu will remain at the top of the screen in most areas of the DHIS 2 application.

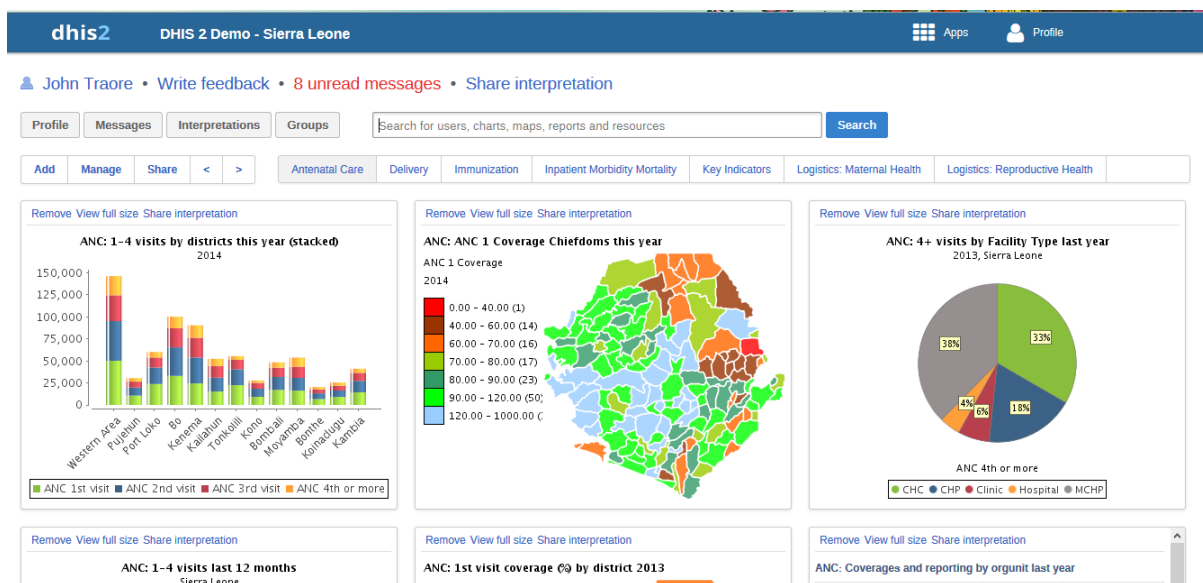


Figure 3 DHIS 2 Dashboard screen

The dashboard module allows the user to fill up Dashboards with their favorites statistics for easy access. Users can organize their statistics by creating dashboards and name them relevant names. In Figure 3 the dashboards were named “antenatal care”, “delivery” and “immunization” etc. Users can display the Dashboard they want to view by clicking the tab for it. Each dashboard can be filled with statistics. In order to add a statistic it first has to be saved as a favorite, and then it can be searched for with the search functionality visible in Figure 3 and added to the relevant dashboard.

Standard reports can combine tables and charts in the same report. The user can download them as PDF documents, which makes them usable for printing and sharing offline.

Dataset reports are reports that look like the data entry schemes filled in when the data are entered into the database. They also have the same appearance as the paper reports from the facilities. The dataset reports are downloadable either as PDF files or as Excel files.

The data visualizer module (Figure 4) is a tool to make charts and tables. It integrates in multiple ways to visualize data from the database. The data visualizer is designed for making comparisons. Several types of charts are available. Users can save the charts as favorites and add them to their dashboard. There is also an option to download the charts as PDF documents for more printer friendly versions.

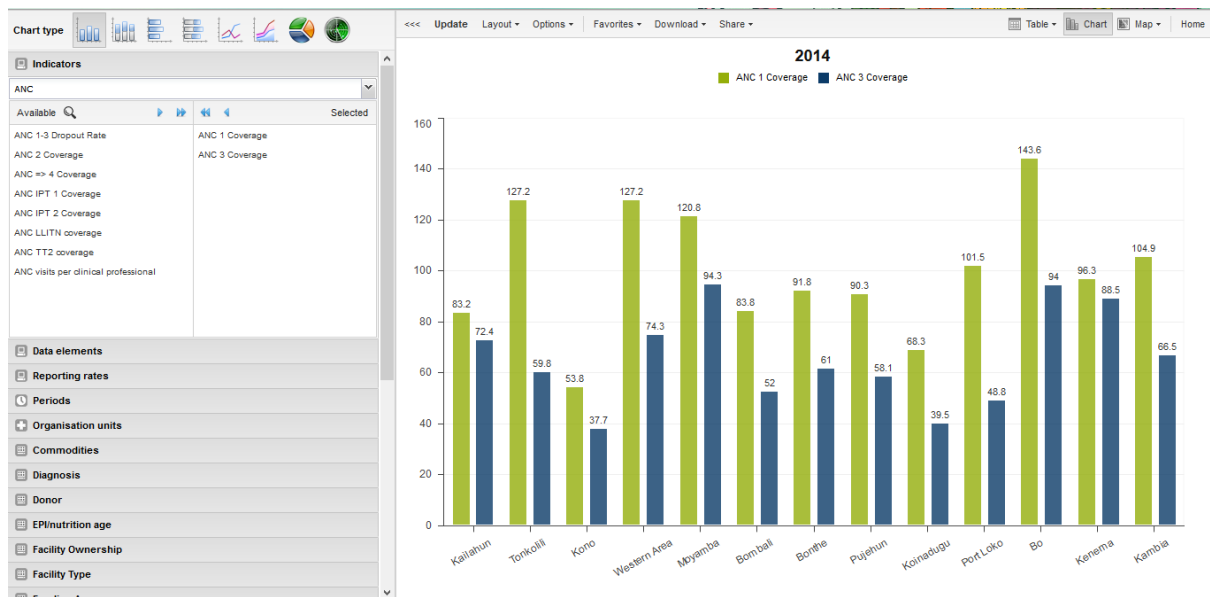


Figure 4 The data visualizer module in DHIS 2 visualizing ANC 1 coverage and with ANC 3 coverage.

There are various options to customize the charts. Figure 4 displays a comparison of how attendance rate in the first and the third antenatal care visit.

The data visualizer module can make graphs and tables and a Geographical Interface System (GIS) module that can display the data on a map.

Report tables are configurable outputs of data. The data can be downloaded as PDF, Excel, XML or CVC files, making them available for incorporation into a larger report together with data from other sources.

Organizational unit distribution reports are reports that show how many organization units there are in an area and what types they are. One can for example display the number of rural and urban facilities in each district, or how many of the facilities in each district are private, public or owned by nongovernmental organizations (NGOs). The reports can be downloaded in multiple file formats.

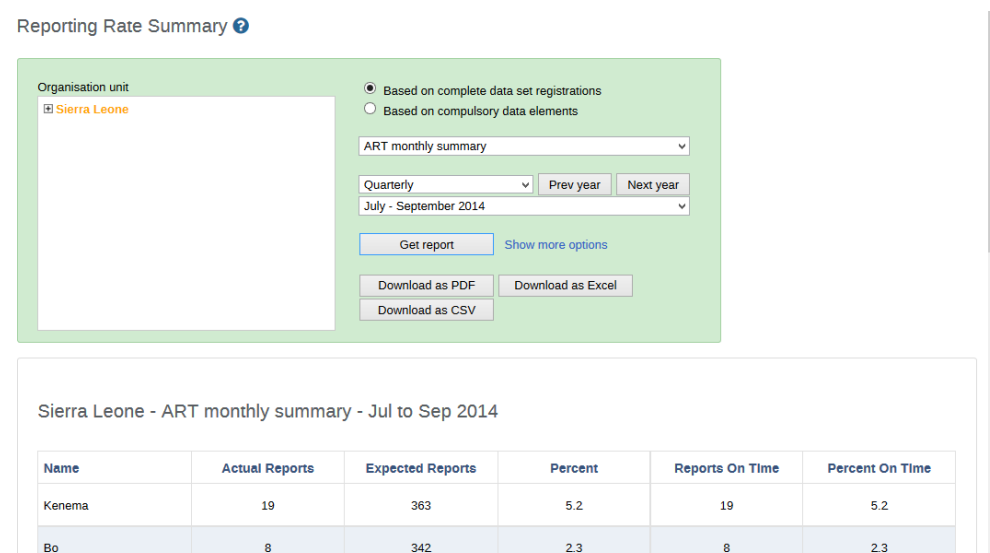


Figure 5 DHIS 2 Reporting rate summary

The reporting rate summary module (Figure 5) creates reports over the frequency and timelines of reporting. Data domain and a period of time must be defined to have the report generated by DHIS 2. The reporting rate summary can give the analyzers an idea of how representative the data is because it reveals the frequency and the amount of reports the data are based on.

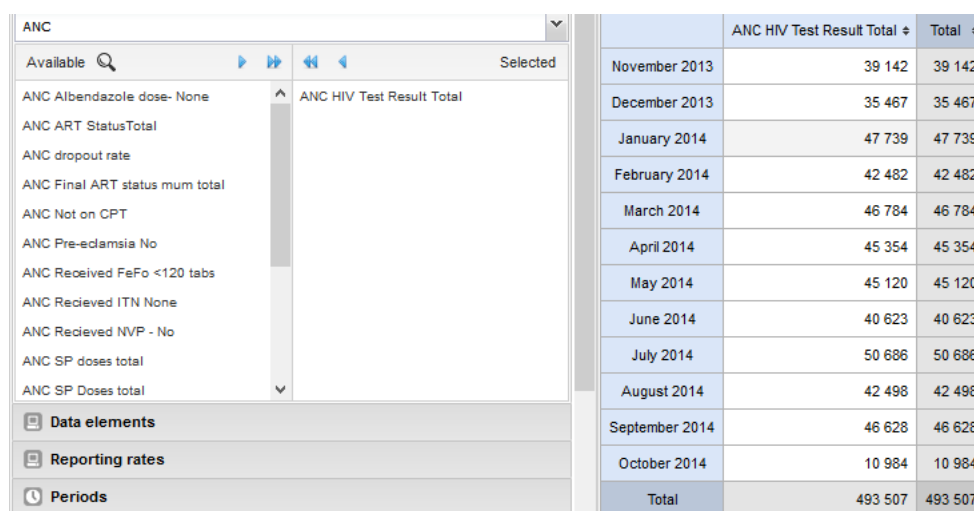


Figure 6 DHIS 2 pivot table module

The Pivot table module (Figure 6) of DHIS 2 is a dynamic tool to quickly summarize and arrange data (Team Dhis Documentation, 2014). The pivot table arranges data in columns and rows. The users can for example make a chart where indicators are displayed as columns and months are displayed as rows.

In addition to the data analysis modules, there is also a **Data Entry module** (Figure 7) of DHIS 2 where data can be recorded into the DHIS 2 database. Selecting an organization unit, a data set and a period of time is a prerequisite for data entry.

dhisis2 DHIS 2 Demo - Sierra Leone

Sierra Leone

Data Entry

Sierra Leone - August 2014 - No Data Element Selected

Run validation
Print form
Print blank form

Organisation Unit: Sierra Leone
Data Set: ART monthly summary
Period: August 2014
Implementing Partner: African Medical and Research Foundation
Project: Improve access to clean water

HEALTH SECTOR RESPONSE GROUP (ARG/MOHS)

ART CLINICAL CARE FORM - MONTHLY DATA COLLECTION/SUMMARY FORM

| Clinical Care/ART Indicators | | MALE | | | | FEMALE | | | |
|------------------------------|-----------|------|-------|-------|-----|--------|-------|-------|-----|
| | | <15 | 15-24 | 25-49 | >49 | <15 | 15-24 | 25-49 | >49 |
| STAGING | STAGE I | | | | | | | | |
| | STAGE II | | | | | | | | |
| | STAGE III | | | | | | | | |
| | STAGE IV | | | | | | | | |

Figure 7 DHIS 2 Data Entry Form

The **Data Quality** module (Figure 8) has multiple sub modules that relate to data validation. The purpose of data validation is to prevent poor quality data from entering the database. DHIS 2 validates the data by testing them against a set of validation rules. An example of a simple validation rule is that the maximum field has to be a larger number than the minimum field. If a user runs a validation test that fails this rule, DHIS 2 will display a notification that the “*Maximum*” field is lower than the “*Minimum*” field and the user will realize the typing mistake.

dhisis2 DHIS 2 Demo - Sierra Leone

Validation Rule
Validation Rule
Validation Rule Group

Data Analysis
Validation Rule Analysis
Std Dev Outlier Analysis
Min-Max Outlier Analysis
Follow-Up Analysis

Data Quality

Validation Rule
Add, modify, view and delete validation rules. Anomalies can be discovered by running validation rules against the data.

Validation Rule Analysis
Run validation rules in order to unveil anomalies and errors in the data in the database.

Min-Max Outlier Analysis
Analyze potential outlier values based on min and max values. Outlier values can be examined and marked for follow-up.

Validation Rule Group
Add, modify, view and delete validation rule groups. Provides the ability to group and run validation rules together.

Std Dev Outlier Analysis
Analyze potential outlier values based on standard deviations. Outlier values can be examined and marked for follow-up.

Follow-Up Analysis
View or edit data values marked for further follow-up during data entry or analysis.

Figure 8 DHIS 2 Data quality select screen

DHIS 2 organizes organization units as a hierarchy (Figure 9). In the case of Malawi, the top layer in the hierarchy is the Ministry Of Health (MOH). The layer beneath it consists of six units. Those six units are Malawi's five administrative zones and the Central Hospitals.

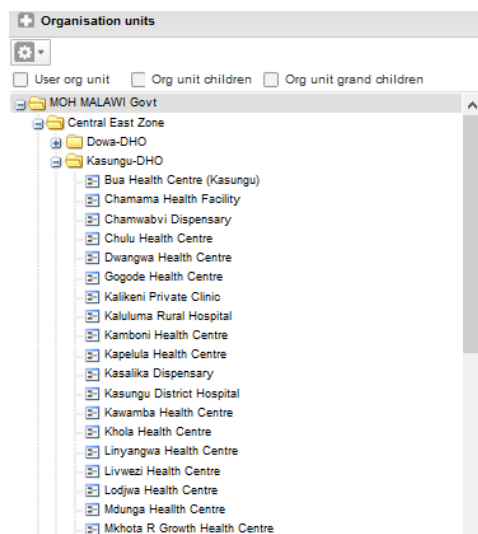


Figure 9 Organization units DHIS 2

Below each zone in the hierarchy are the districts they contain and below the Central hospitals is each specific hospital. In the hierarchical layer beneath the districts are the facilities within that district. How this hierarchy works is illustrated in Figure 10. The organizational units allow users to view data in a local or countywide settings or anything in between as they wish.

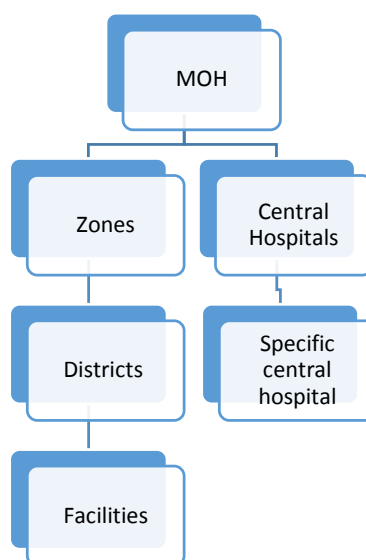


Figure 10 Organization layers hierarchy

DHIS 2 also has functionality that allows users share their statistics and how they interpret them so other users can provide their comments (Figure 11). To use this functionality a user has to create statistics. They can then share that statistics with and invite for comments on it, as shown below.

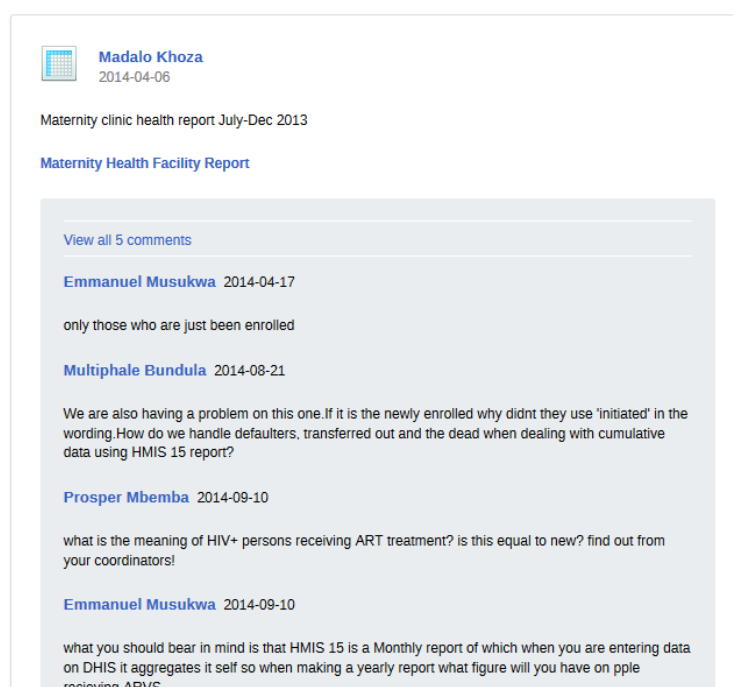


Figure 11 DHIS 2 interpretations

The messaging functionality of DHIS 2 works very similar to email. It can be used for sending messages to other DHIS 2 users. In a similar fashion to email, users type in the username of the account they are sending the message to, a subject and a message. There is also “to org unit” functionality where users can send a message to organization units (district, facility etc), meaning they can send a message to every account in for example a district.

An important feature is that the modules of DHIS 2 work independently of the rest of the software, so developers can add, remove or modify modules without affecting other parts of the software. An important feature of DHIS 2 is that it can be integrated with other software used in the health system.

2.3 Malawi

Malawi is located in Southern Africa, east of Zambia, west and north of Mozambique. It is a landlocked country with a total area of 94,080 square kilometers, which makes it the number 100

largest country in the world. It encompasses most of the coastline of a 580 km long and narrow lake (Lake Nyasa) within its borders. Lake Nyasa contains more fish species than any other lake on earth (CIA, 2014).



Figure 12 Malawi's location in Africa

Figure 13 Map of Malawi

Lilongwe is the Malawian capital. The country consists of 29 districts. Each district is an administrative unit with their own political representatives. Malawi is a multiparty democracy with 11 political parties.

There are two systems of government administration in Malawi: Central and local level. The central government organized through a central office coordinates the 29 districts. The central office is called the Office of the President and Cabinet (OPC) (Galimoto, 2007).

2.3.1 History

Malawi was established as a British protectorate in 1891 called Nyasaland. In 1964, it gained its independence from the British Empire and became the Republic of Malawi. In 1994, it had its first multiparty election and put in place a provisional constitution after it had been under one party rule for three decades. The constitution came into full effect on the 18th of May of 1994 (CIA, 2014).

2.3.2 Population and health indicators

Malawi had an estimated population size of 16,777,547 people in 2013 (CIA, 2014). Malawi's capital, Lilongwe, had a population of 821,000 people in 2009 (CIA, 2014). The population consists of more than nine ethnic groups. The largest ethnic group is the Chewa, which constitutes 32.6% of the population. The official language of Malawi is Chichewa, which is spoken by 54.2% of the population (census 2008) (CIA, 2014).

As the figure below illustrates, 44.7% of the population is younger than 14 years. 20.6% are between 15 and 24 years, 28.5% between 25 and 54 years and 6.3% are 55 years and above. The median age (50% of the population older and 50% under) in Malawi is 17.3 years. For comparison, the median age in Norway is 39.1 years. Thus, Malawi has a very young population.

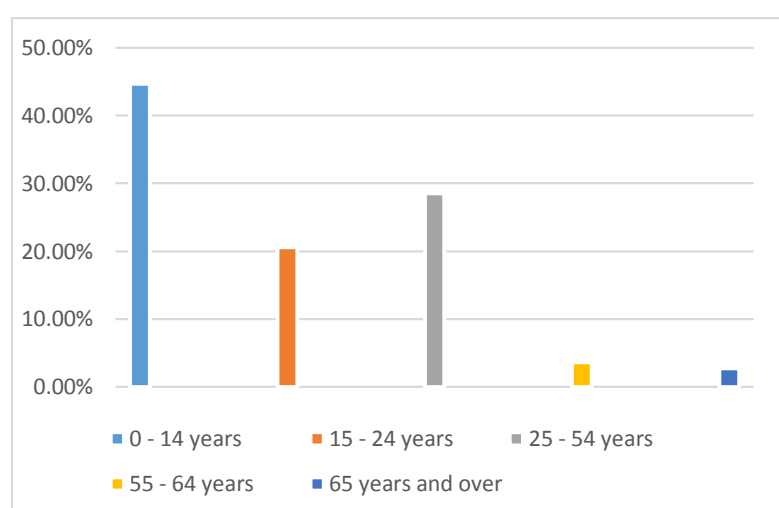


Figure 14 Age distribution in Malawi

The birth rate in Malawi is 39.98 births/1000 inhabitants (2013) and the death rate is 12.54/1000 inhabitants (2013) (CIA, 2014), hence the population is rapidly growing. Malawi's health expenditures are 6.6% of the country's Gross Domestic Product (GDP) (2010) (CIA, 2014). For comparison, the health expenditures of Norway are 9.10% of the GDP.

The maternal mortality (defined as death of a woman while pregnant or within 42 days after termination of pregnancy) rate is 460 deaths/100,000 births (2010), which is the 24th highest in the world.

HIV/AIDS is a huge problem with an adult prevalence rate of 11% (2009) in Malawi. An estimated 920,000 people are living with aids and the estimated number of deaths from AIDS was 51,000 in 2009 (CIA, 2014). The ratio of underweight children below 5 years is 13.8% (2010) (CIA, 2014).

Given these facts, it is obvious that the prospects of improving health care and health status in Malawi can be enormous.

2.3.3 Status of implementation of DHIS 2 in Malawi

Malawi has currently implemented DHIS 2 in all 29 health districts. The process was, as stated before, aided by the University of Oslo and funded by the Norwegian Agency for Development Cooperation (NORAD) and United Nations Children’s Fund (UNICEF).

The introduction to DHIS 2 in Malawi happened during the restructuring process in the beginning of this century. It was developed and gradually implemented from 2004. In December 2010 the Malawian Ministry of Health started to pilot an upgrade from DHIS to DHIS 2. The pilot included five districts and lasted 6 months. Rollout in the remaining 24 health districts happened from September to December of 2012. As a picture of DHIS 2 implementation in Malawi, one can look at the amount of information entered into DHIS 2. The data was entered into the database by 29 (one in each health district) HMIS officers and by clerks at the 29 district offices. Each district office received data in the format of paper reports from the district health facilities. Reporting rate is a comparison of the percentage of actual data reports submitted and how many reports were expected (Table 1). The statistics in Table 1 originates from the DHIS 2 database.

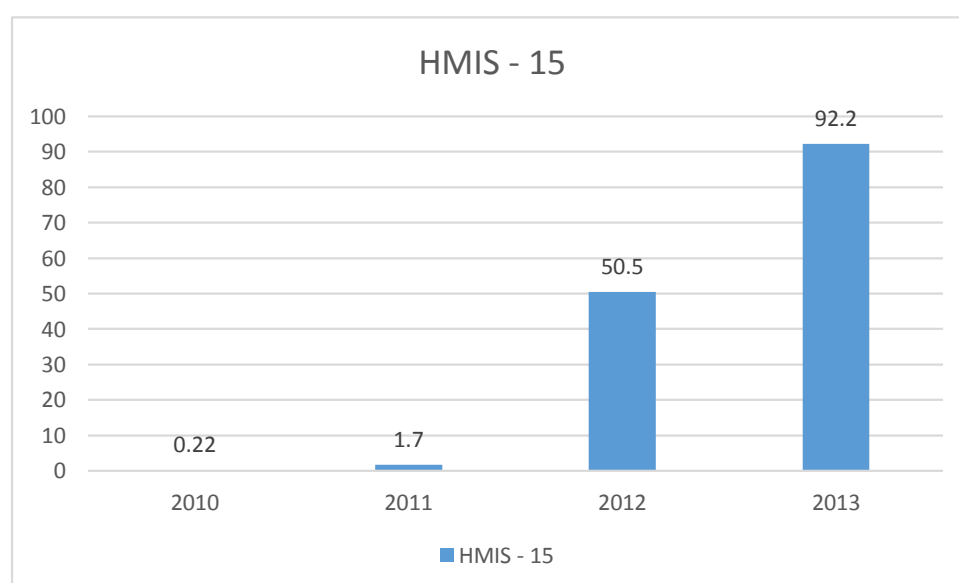


Figure 15 DHIS core data yearly reporting rates

HMIS 15 is the core data that Malawi’s Department of Health collects from health facilities. Figure 15 shows that there has been a steep increase in HMIS 15 reporting rates since 2010 (0.22%). In 2013 it was above 90%, indicating a successful implementation of DHIS 2. The chart shows the gradual

replacement of DHIS 1 by DHIS 2. Thus, the increase in actual data reporting is not as high as the chart indicates, as reporting occurred also in 2011/2012.

The HMIS 15 data set contains 98 data elements categorized in 11 categories. The most important categories are vaccination, disease, child health, maternal services and ongoing treatments.

When looking at reporting rates for different districts and levels, there is some variation and especially the central hospital has a low reporting rate (Table 1).

| Name | Actual Reports | Expected Reports | Percentage | Reports On Time | Percentage On Time |
|-------------------|----------------|------------------|------------|-----------------|--------------------|
| Central East Zone | 1161 | 1200 | 96.80% | 401 | 33.4 |
| South East Zone | 1726 | 1836 | 94% | 424 | 23.1 |
| North Zone | 1373 | 1476 | 93% | 281 | 19 |
| Central West Zone | 1411 | 1584 | 89.10% | 183 | 11.6 |
| South West Zone | 1432 | 1644 | 87.10% | 118 | 7.2 |
| Central Hospital | 3 | 24 | 12.50% | 0 | 0 |
| MOH MALAWI Govt | 7106 | 7764 | 91.50% | 1407 | 18.1 |

Table 1 Malawi reporting rate summary 2013 for core data

It should be noted, that the data quality is not assessed in these numbers. The number of reports submitted on time is low, thus all districts constantly delay the reporting.

CHAPTER 3 BACKGROUND ON USABILITY AND USER DOCUMENTATION

In order for DHIS 2 to aid effective health information flow in Malawi, it needs to be efficiently integrated in the workflow of health workers. Health workers need to see how the information system benefits them in their work and the system has to be easy to use so that it can fulfill the intentions. In general, information systems should be experienced as useful tools rather than new obstacles. An intuitive interface can make it cheaper and faster to train users for efficient use of the software and it can lower error rate and aid workers in producing higher quality work. Thus, usability and user documentation principles in the DHIS 2 software are very important.

The terms usability and user friendliness are often used interchangeably. However, many researchers and designers prefer the term usability, because it does not mean that an interface or a system is friendly to the user, it rather means it is an effective tool to accomplish work (Nielsen, 1994).

3.1 Usability

The improvement of usability has enabled the spread and use of technology to a large portion of the population. In an ageing world population there is an increasing need for user interfaces that make technology accessible to more people. ISO is a set of internationally recognized standards that ensures services are reliable, safe and of good services ("ISO Standards - ISO," n.d.) The ISO 9241 standard focuses on effectiveness, efficiency and satisfaction. The usability goals, which focus on the last two traits, lead to more practical evaluation: **Learnability, efficiency, rate of errors, memorability and subjective satisfaction**. The utopian goal would be for all user interfaces to be excellent at all these attributes. However, the reality is that designers need to make tradeoffs in user interface design.

Learnability is how easy the system is to learn. It indicates how fast a user will reach a sufficient skill level to start getting work done with the system. Systems with good learnability will give a steep learning curve. Typically, the learning curve starts at zero, which means that the user is not able to use e.g. a health information system the first time trying. A steep curve indicates fast understanding and ability to gain information from the system. Learnability is in many cases the most important usability attribute because the first assignment the user has with any new system is to learn to use it (Nielsen, 1994).

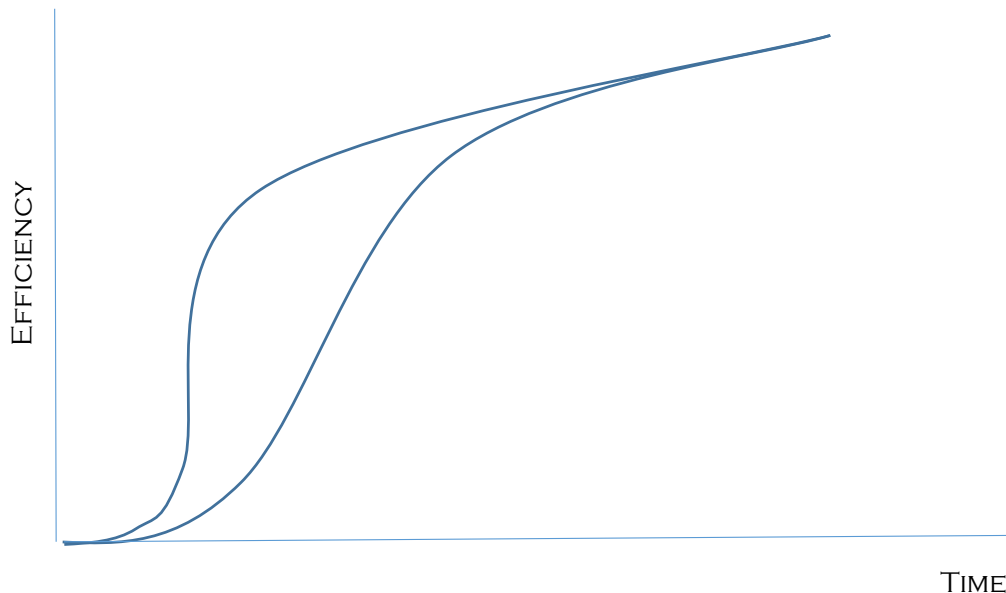


Figure 16 Learning curves

A learning curve illustrates the pace of learning from a novice user to skilled user. With repetition of a task, a user will increase the speed and performance in a task over time. Learning generally happens more quickly in the beginning and after a while reaches a plateau, which means learning happens at a slower pace (Ritter & Schooler, 2001).

Efficiency refers to efficiency of use. This points to *“a user’s steady rate of performance at the point where the learning curve flattens out”* (Nielsen, 1994). This level is different for every user. Some users may be satisfied at a lower point in their learning curve and will not bother to learn functions that could improve their efficiency, while other users may strive for a higher skill level and achieve better efficiency (Nielsen, 1994).

Memorability refers to how easy the system is to remember. Systems with good memorability are easy to get back to after not having used the system for some time. Memorability also refers to how easy it is for casual users to relearn a system they only use occasionally. These users do not have to learn the interface from scratch (Nielsen, 1994). An example of an interface element that is hard to learn but easy to remember is the method of closing applications in an IOS 7 Apple device (e.g. Iphone). The way to do this is by first double clicking the main button on the device. This will make a list of the open applications appear on the screen. Then you close the applications by pushing them out of the screen using the touch functionality. This concept is not easy to understand the first time you see it, but when you have learned it, it is probable that you will remember it the next time you want to close something.

Rate of errors refer to how many errors a user will commit per unit of time using a system and how easy it is to recover from them. According to a common definition, an error is *“any action that does not accomplish the desired goal”* and one can measure the error rate by counting the *“number of*

errors that a user makes when performing a specified task” (Nielsen, 1994). Errors can of course be more or less serious. Errors that cause failure to complete the work or errors that are difficult to discover and lead to flaws in the work must be minimized in the system. Smaller errors that just slow the user down are more acceptable (Nielsen, 1994).

Subjective Satisfaction refers to how pleasant the system is to use and how the user subjectively perceives the system - in other words how likeable the system is. This category is most important for recreational software like painting software or games as these activities are mainly motivated by subjective positive perception. Efficiency is not always a goal in these systems, the fun factor is more important.

The field of creating compelling user interfaces is known as Human Computer Interaction. Human Computer Interaction is a combination of a large number of disciplines. It mainly consists of computer science and experimental psychology. Human Computer Interaction also integrates lessons from ergonomics, sociology, anthropology education industrial psychology, instructional and graphic design, technical writing and other domains (Shneiderman, Plaisant, Cohen, & Jacobs, 2009).

One of the goals of Human Computer Interaction is to make the interface “*disappear*” from the user. It should make the user focus all their attention at whatever work they are trying to do, without the disturbance by the interface. An extreme example of this is the software Dark Room. Dark Room is a text editor software with no functionality other than just writing.

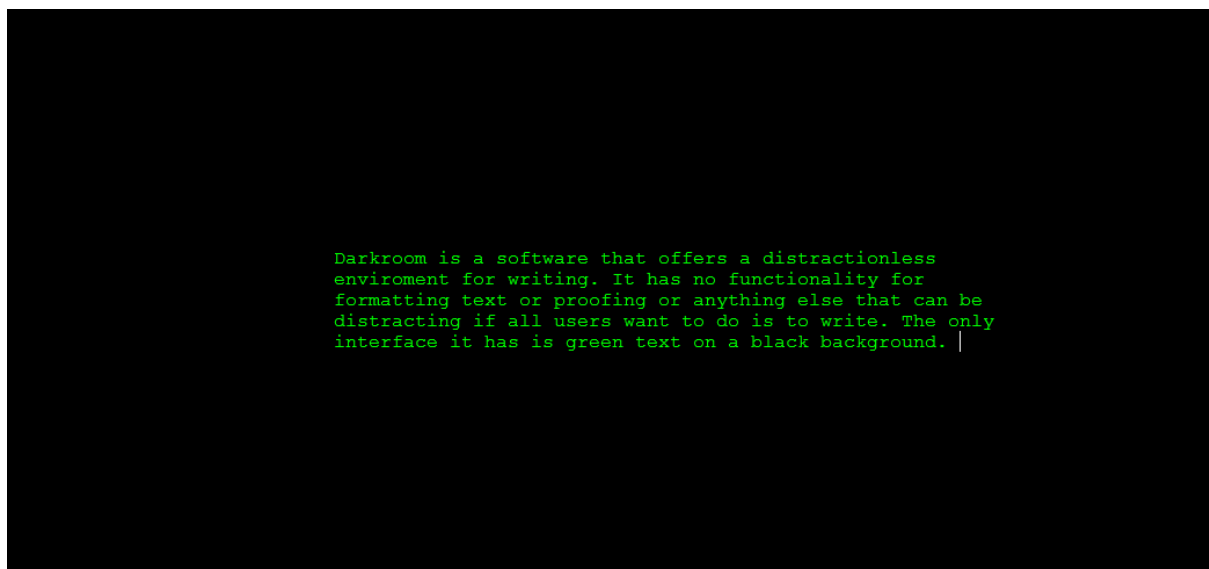


Figure 17 Dark room software for MS Windows

Effective user interfaces also make good sense for business managers, because it increases work

productivity. This may reduce the amount of workstations or employees needed, lessen burnout rate and let workers focus more of their attention at their job tasks (Shneiderman et al., 2009).

According to Nielsen there are **three main dimensions** of how user experience with a system differs from person to person (Nielsen, 1994). One of the dimensions is how much **computer experience** the user has, which can range from minimal to extensive. The next dimension is how **skilled** the user is with one particular system, which ranges from novice to expert. The third dimension is how **knowledgeable** the user is **with the software's subject domain**. For example, in a word processing software, a person needs to have knowledge in the domain of how to format a document as well as skills in the particular word processor, to format a document correctly. In order to learn the skills on how to operate a particular system, one needs to have a certain amount of computer experience. In one particular example, the first dimension would be the skills needed to turn on the computer and open the word processor. The second dimension would be to use the word processor to create and format a document and the third dimension would be knowledge in the subject matter to write about. General writing skills and general knowledge of how a properly formatted document should look would be included in the third dimension. It is not enough to be skilled in the use of a particular system, if knowledge in the subject domain is lacking. All three dimensions have their own learning curves.

Some systems are so complex that even very experienced users will not have full expertise in all domains of the system. These include many systems of some complexity. Examples of extremely complex systems where few users have full expertise are computer operating systems. An operating system manages everything a computer can run and has tens of thousands of functions. The operating system manages functions as when to activate the computers fan. This can be compared to the autonomous nervous system in the body. In other words, the operating system handles complex processes that are largely outside conscious control of the user.

A common way of appealing to both expert and novice users is by including two sets of menus. One set of menus called "*short menus*" that contain the simpler and most commonly used functionalities and one set of menus called "*long menu*" that contains expert type of functionality and advanced customization options. This way one can offer advanced functions to the experts without confusing the casual users (Nielsen, 1994).

Usability is a wide research field with countless books and articles written on it. However, this thesis will not delve deep into usability but rather limit the scope and focus mostly on user documentation.

3.2 User documentation

User documentation is defined as *explanations on how to use a system* (Sommerville, 2011). Another definition is “*the description or manual for a product or a service provided to the end user*”. The purpose of user documentation is to *assist end users to use a product or service* (“What are user documentation and technical documentation?,” n.d.).

User documentation can incorporate different kinds of manuals, online support, tutorials, balloon help functionality and other. *Help functionality* includes functions designed to help the user, while *user documentation* also encompasses material outside the software, for example physical manuals.

Interface-based documentation is documentation that is integrated within the user interface of a software. Examples are tutorials if they are integrated in the interface, balloon help, pedagogic error messages or online help. PDF manuals or physical manuals are not a part of the software interface, so they are not interfaced based documentation. However, they are termed “*online*” as long as they are supplied in a digital format.

User documentation should distinguish between various expertise levels. It is particularly important to distinguish between end users and system administrators (Sommerville, 2001). The table below includes some examples and descriptions of user documentation.

| Documentation category | Type of interaction | Attributes |
|---------------------------------|---------------------|---|
| Procedures | Task based | Procedures are instructions on how to perform a task. Overview topics are broader in scope and contain more conceptual information. Procedures are sequential, explicit, start with the user’s goal, lists side effects and implications of carrying it out. |
| Tutorials, | Task based | Tutorials aim to increase retention and are often more visual than procedures. Tutorials can provide a low risk and a controlled learning environment. Tutorials may use strategies to promote retention, for example video recordings, exercises and graphics. |
| Balloon help and error messages | Interfaced based | Balloon help and error messages are often integrated in the interface of the software. These may be exploration based, not focused on a goal and help users as they explore the interface. |

Table 2 Categories of documentation (Farkas, 1998)

3.2.1 Procedures

Procedural discourse is a way of instruction that tells you explicitly what to do. A few examples of procedures are recipes, Ikea instructions and so on. Procedures in computer documentation usually start with the task the user wants to accomplish. They also list the side effects or the implications of carrying out the procedure. For example, a side effect when installing software may be that it is consuming space on your hard drive. The procedure then guides the user through accomplishment of the goal in a stepwise fashion (Farkas, 1998).

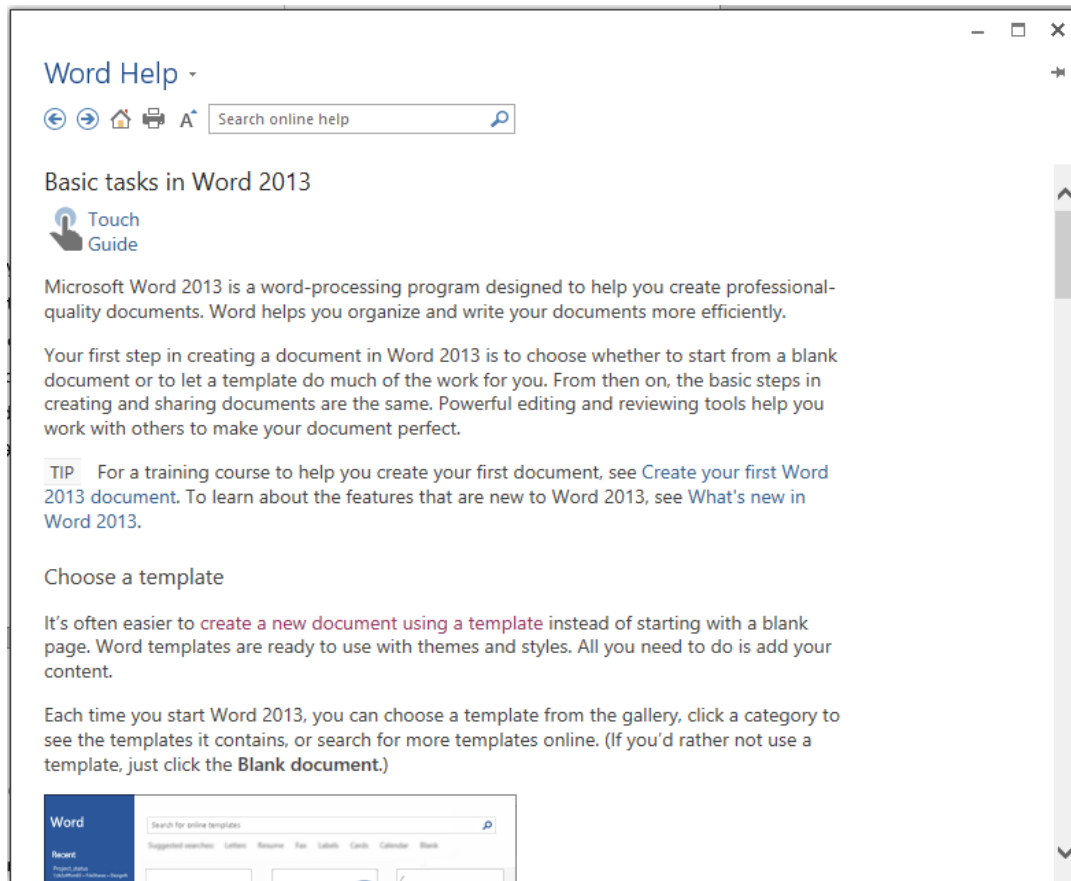


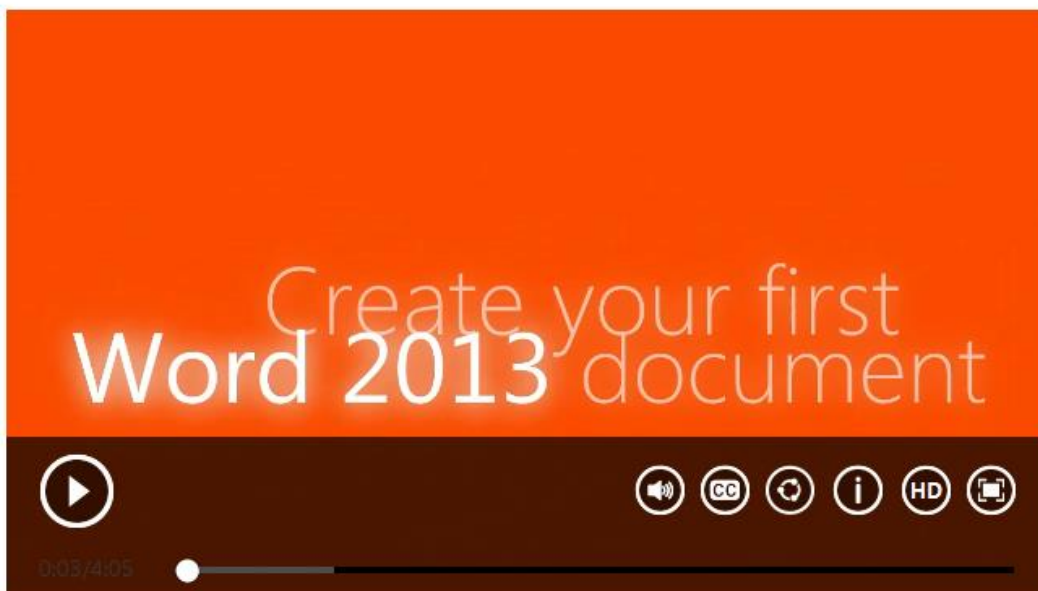
Figure 18 Example on Overview topic on basic tasks in Word 2013

An **overview topic** (Figure 18), also called a concept topic, is a topic that is broader in scope and contains more conceptual information than a procedural topic. An overview topic often explains a concept. This may be concepts of indicators in a health information system and include links to procedural topics about how to add or edit an indicator. An overview topic can be several paragraphs and include graphics. The user can jump straight from the *help topic* to the *overview topic* and the overview topic is usually available in the *online index* (Farkas, 1998).

3.2.2 Tutorials

Tutorials are a different category of user documentation. Tutorials have similarities to procedures, but one difference is that they should include detailed conceptual information. They can also include exercises, reviews and other strategies to promote retention. Tutorials often guide the user through the exercise. There are different kinds of tutorials and some examples are video tutorials, online tutorials and printed tutorials. Video tutorials simulate interaction with a software by guiding the user through tasks. Video tutorials often display the exact steps users must take and then show the actions being carried out using a recorded demonstration (Shneiderman et al., 2009).

Video: Start using Word



The best way to learn about Word 2013 is to start using it. Create a blank document and learn the basics of adding and formatting text.

Figure 19 Video Tutorial example from Word 2013

Online tutorials include conceptual information, graphics, exercises and examples. One of the strengths, but also a risk, in online tutorials is that the tutorial designer can provide a very controlled environment. The tutorial designer can set up a safe environment and efficiently teach the learning objectives set by the designer. The risk of is that the tasks in the tutorials may be different from what the learner is trying to achieve.

3.2.3 Interface-based documentation

Interface-based documentation is help functionality embedded in the User Interface (UI). Examples of interface-based documentation include balloon help, some forms of tutorials and error messages.

Interface-based documentation is user controlled, which means for example it can depend on where the mouse pointer is located.

Balloon help was introduced in the Macintosh operating system with the System 7 release in 1991. The term balloon help was coined by Apple Computers™, but has also been called “*tool tips*” by Microsoft. Balloon help is widely adopted in software and various websites.

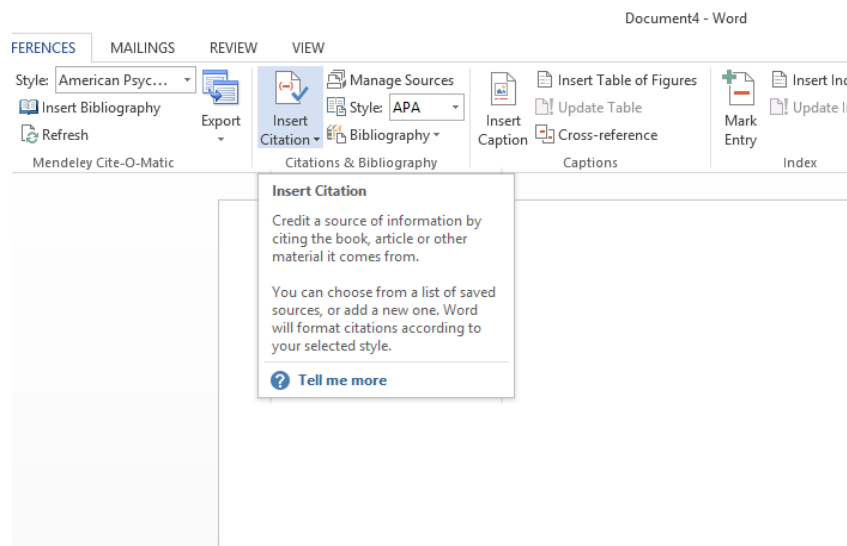


Figure 20 Balloon Help on inserting citation, example from Word

Balloon help (Figure 20) is a user-initiated kind of help. In order for balloon help to be displayed, the user has to hold the mouse cursor over an interface element (e.g. an icon or a piece of text) for a predefined amount of time (usually around 1 second) and this will invoke the appearance of a box (“balloon”) containing a short description of how this element functions. Sometimes there is a link to a more thorough explanation as seen in Figure 20. Interface-based documentation is documentation where the user does not have to look through an index or does not have a stated goal. With balloon help, the user explores the interface, asks, “*What is this*” and “*what is this for*” and looks for answers in the interface itself.

Balloon help as a way to compensate for limitations of a graphical user interface (GUI). When too many elements fill up the screen at the same time, elements can easily clutter the screen. There is not enough screen real estate to explain all elements. Names and text elements often have to be too brief to be meaningful. Balloon help is a way to add supplementary information. Balloon help also have to be brief, but they can contain hyperlinks to more thorough explanations. When users have difficulties realizing the function of an icon or graphical objects, they can utilize balloon help.

3.2.4 Minimalistic documentation

Farcas et al. set balloon help in the context of minimal documentation coined by John Carroll (Carroll & Rosson, 1987). Carroll observed that users get impatient if they spend much time learning a software application without getting any tasks done. He also observed that users prefer the briefest possible documentation they need to accomplish their work. Farkas saw Balloon help as an online implementation of the original minimalist idea (Farkas, 1993).

Minimalism, in the context of user documentation, is a task-oriented method of writing documentation. All the categories mentioned above can have minimalistic attributes. The researcher John Carroll observed that users wanted to start real work tasks with a software as soon as possible and traditional documentation and training materials slowed them down (Mackenzie, 2002). Therefore he wanted to design documentation in line with the minimalist principles which are summarized below (Mackenzie, 2002).

Principles of minimalistic documentation (Mackenzie, 2002):

1. *Allow learners to start on meaningful tasks immediately.*
2. *Minimize the amount of reading and other passive parts of learning by allowing users to fill in the gaps themselves.*
3. *Include error recognition and recovery activities in the instruction.*
4. *Make all learning activities self-contained and independent of sequence.*

User documentation has moved in the direction of minimalist principles. Learners prefer trying out actions on the computer rather than reading lengthy manuals (Shneiderman et al., 2009). Users do not read manuals from beginning to end; rather they use them only for problem solving, after trying to figure out the solution on their own. This is why minimalist documentation is divided in self-contained sequences. Minimalism also tries to draw on the assumed previous knowledge of the user to transfer it to new contexts.

In documentation that follows minimalist principles, readers can understand every section independently of the rest of the manual. It is designed to be there for users who need it and to not disturb users when they do not need it. It seeks to help individual users to work the way they choose to and not force any particular way of doing a task. It uses real tasks as examples so the users can learn while doing actual work. Layering is a minimalist technique that limits what is shown to the immediately useful information.

Minimalism is focusing on helping users recover from errors, because errors in minimalism are seen as a necessary part of the learning process. As Carroll puts it *“Recognizing and recovering from a particular error might be a good pedagogical opportunity for the user”* (Carroll & Meij, 1996).

Some typical examples of documentation with minimalist attributes are balloon help and error messages. Well-written error messages can follow the second, third and fourth minimalist principle described on page 42. Balloon help can follow all four principles.

3.2.5 Manuals

A manual is a collection of instructions. The purpose of manuals is to support users of a particular system. Manuals contain instructions on how to perform actions and they are meant to be a resource for troubleshooting and solving problems. Online documentation and manuals commonly replace paper manuals because of the cheap distribution costs of CDs and internet downloading. In the beginning, online help was usually just an identical digital version of the paper documentation (Shneiderman et al., 2009).

Online manuals have an interface that is often independent of the system (Shneiderman et al., 2009), hence they are not embedded in the interface of the application. Looking up the online manual means that the users have to leave the task they work on.

On the other hand, *“online help”* refers to help that integrates with the interface and a *“help”* button usually invokes it. Online manuals and online help have many benefits to printed documentation. They are physically available whenever the computer is available and they take no additional physical space. Vendors can utilize online distribution to update the documentation. Navigation features can be more efficient than paper navigation because of hyperlinks and search functionality. It is advantageous that the table of contents is always visible on the side of the screen, so the user gets an overview and navigates faster. The table of contents should have expanding and contracting functionality so the user can click at for example a chapter heading to view all the sub headings inside that chapter. In addition, online manuals can incorporate interactivity, for example bookmarks, user comments and tags of text. As mentioned, it is also cheaper to distribute and duplicate online manuals than paper documentation (Shneiderman et al., 2009). Thus, there are numerous favorable features of online manuals as compared to analog versions.

Novick and Ward performed a study on computer use at work and found that the users did not use printed manuals at all to solve problems, and that they would rather abandon a task. The median time they spent on online documentation was 25% of their total problem-solving time consume

(Novick & Ward, 2006). The reasons it was not used more were mainly because of navigation features.

The above cited study by Novick and Ward was pursuing why users do not read manuals. The study was conducted on men and woman in various working contexts and with varied skills in the application of computers. Through interviewing the participants, they identified a set of subjects in the complaints towards online manuals (Novick & Ward, 2006):

Navigation

Search terms

Level of explanation

Screen real estate

uncertain boundaries

Navigation: Many of the participants found computer applications difficult to navigate. They often knew the procedure for doing a task, but had forgotten where in the software interface the needed functionality was located. When they consulted the online documentation, they found it difficult to navigate the manual as well (Novick & Ward, 2006).

Search terms: A common complaint was about “*search terms*” in the documentation’s search function. The search terms in the documentation sometimes have to match the terminology of the users. If the documentation uses different terminology than the user, the search queries will turn up empty (Novick & Ward, 2006).

Level of explanation: The participants in the Novick and Ward study stated that the “*level of explanation*” in documentation rarely suited them. Some participants felt it was explaining items so basic that it caused annoyance and others felt it was written in too advanced language. They mentioned use of jargon that made the explanations difficult to understand (Novick & Ward, 2006).

Screen real estate: Participants of the study claimed that help windows often hid or were hidden by the application window, making it difficult to see both at once (Novick & Ward, 2006).

Uncertain boundaries: For systems that had to be integrated with many other systems to work properly, the boundaries between the systems were sometimes unclear. Novick and Ward refer to this as “*uncertain boundaries*”. An example is a web application; the error could be either in the browser or in the application. If the boundaries are uncertain, the user documentation is unlikely to cover the problem (Novick & Ward, 2006).

For usual software like for example web browsers or MS Office applications, there are vast amounts of user documentation online, which are not made by the manufacturers. This user documentation

is often blogs or websites dedicated to particular software or in enthusiast forums online. Links to these forms of user documentation are easy to find using search engines like Google or Yahoo. A study conducted on university students showed that the participants preferred search engines like Google for problem-solving rather than manufacturer produced online help (Welty, 2011).

3.2.6 Guidelines for error messages

In order to be a well written error message the writing should adhere to a series of attributes (Nielsen, 2001). They should be:

Explicit: An explicit error message lets the user know without a doubt that something is wrong. An explicit error message tells the user that for example an event did not transpire. In the case of DHIS 2 it could be that data was not entered into the database.

Human-readable: A human readable error message explains in plain text what the error is. An example of a non-human readable error message is *"Error code 3534"*. It should explain the error, for example *"The printer is out of black ink"*.

Polite: Polite error messages do not invoke undesirable feelings. The user should not feel insulted by the message.

Precise: Error messages should be precise and tell users exactly what the problem is. Vague statements that can have several meanings are imprecise.

Constructive advice: Error messages should give constructive advice on how to correct the error. In addition to informing about the error, it should point the user the right way toward a solution or narrow the possible solutions down for the user.

For the web:

Visible: On the web, error messages are sometimes difficult to see. Helpful error messages should be visible and ideally make the user perform some action to make sure they acknowledge reading the message.

For reducing unpleasantness:

Preserve: An error message should preserve as much of the users work as possible. For example if the user is typing in credit card information and making a mistake, he or she should not have to type all information again. An opportunity to correct the mistake without losing any of the previous work would be preferable.

Reduce the work: If possible, error messages should reduce the work of correcting the error. This is possible if the application can guess what the user was trying to do and lead him straight to the correct action.

3.2.7 The user documentation of DHIS 2

The DHIS 2 user documentation consists of three manuals and error-messages. Error messages can in this case be considered part of the user documentation. A premise for this is that they are well written, explain the error, and point toward a possible solution. Error messages that have these traits, teach the user how to use the software. The three manuals of DHIS 2 are the “[User manual](#)”¹, the “[End User Manual](#)”² and the “*Help Center*” (requires login to DHIS 2). The three manuals have different scopes and purposes. The “*User Manual*” and the “*End User Manual*” are PDF files that have to be downloaded from the DHIS website or viewed from the website in html format. The “*Help Center*” is the online manual of DHIS 2, which means it has an online interface integrated in the software. The *User manual* is an in depth instruction book of about 400 pages and contains chapters for administrators and people who customize the system for different settings (technical users). It is highly technical and contains guides on how to set up the system for the first time. The *End user manual* is 54 pages and is a stripped down version of the user manual, containing only the chapters on how to use the software from an end users point of view.

The “*Help center*” is a minimal version of the end user manual.

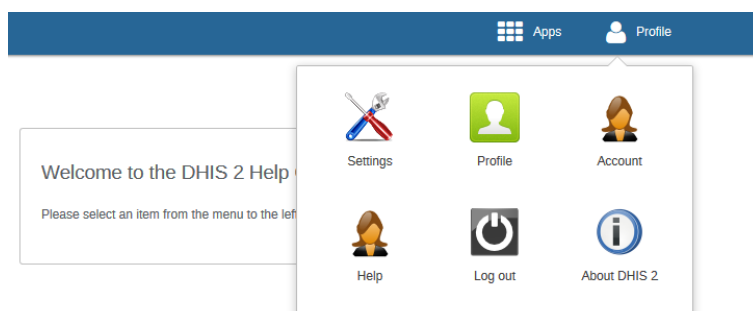


Figure 21 Placement of the “help” icon in DHIS 2

The “*Help*” icon is placed under the profile tab in the top menu (Figure 21). The “*Help center*” (manual) contains short information about what you can do and achieve in DHIS 2. It also explains

¹ https://www.dhis2.org/doc/snapshot/en/user/html/dhis2_user_manual_en.html

² https://www.dhis2.org/doc/snapshot/en/end-user/html/dhis2_end_user_manual.html

some of the different terms used in health information systems. The explanations are less detailed than in the end user manual.

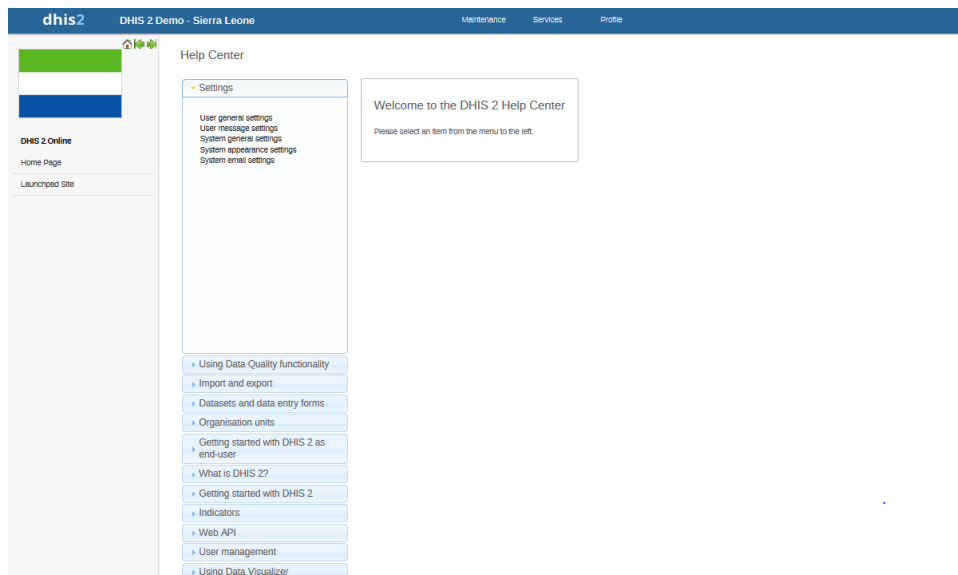


Figure 22 DHIS 2 Help Center screenshot with 1920 x 1200-resolution screen

In the example of a DHIS 2 error message illustrated in Figure 23, the user attempted to type letters in a data entry field that only accepted numbers. The error message states; *“The value must be a number”*. When the user clicks *“OK”*, the software automatically erases the mistakenly typed letters. In this way, the software corrects the user’s error and at the same time teaches the user the correct procedure.

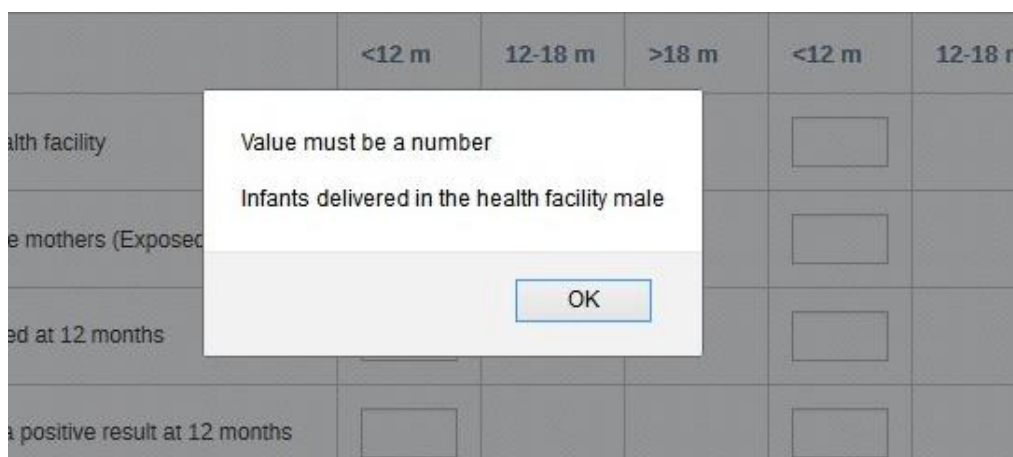


Figure 23 DHIS 2 error message

CHAPTER 4 RESEARCH METHODOLOGY

This chapter outlines the main principles of qualitative, quantitative and mixed research methods. It also provides a general description of the data collection methods used in this thesis. Finally, it describes collection of data in the thesis research.

Most scientific research seeks to answer a question or hypothesis. Scientists often use predefined sets of procedures to answer such questions. The scientist may collect evidence and produce findings that were not determined in advance. One goal of quantitative research is to produce findings that are applicable beyond the immediate boundaries of the study. Qualitative research does this, but additionally it seeks to understand a given research problem or topic from the perspectives of the local population it involves.

4.1 Quantitative research

Quantitative research is concerned with discovering facts about phenomena, rather than the perception of individuals. For example in a quantitative questionnaire, you get values, which can be analyzed using statistical methods.

Most quantitative research aims to prove or disapprove a hypothesis (hypothesis driven). Much hypothesis-based research uses controlled methods like lab experiments and aims to single out how the discrete variables affect the whole. Ideally only one variable should be changed from one experiment to the next to see the effects of that one variable (Shuttleworth, 2008).

Quantitative research methods gather numerical data that researchers can for example put into categories, rank or measure. Quantitative experiments typically consist of measuring different variables, and data analysis happens through comparisons and statistics (Mcleod, 2008).

Quantitative data is always numerical whereas qualitative data can be text, video, or audio.

Strengths and weaknesses of general quantitative research methods are summarized in the table below.

| Strengths | Weaknesses |
|--|---|
| Quantitative data collection and analysis is generally less time consuming than qualitative research | There are possibilities for confirmation bias. Confirmation bias means that researchers miss phenomena because they are focusing on testing a theory or a hypothesis. |
| The empirical results of quantitative research are more independent from the researcher and thus less biased. | The findings are sometimes too abstract or general to be useful. |
| Analysis of numerical data can give the basis for quantitative predictions. | |
| Researchers are able to collect precise empirical data. | |
| Quantitative methods can allow a researcher to construct control groups that eliminates the influences of confounding variables. | |
| Good for testing a hypothesis constructed in advance of data collection. | |

Table 3 Strengths and weaknesses of quantitative research

4.2 Qualitative research

Qualitative research is describing a phenomenon with possible rich textual descriptions as opposed to quantitative research, which gathers numerical data. Qualitative research has been defined as a struggle to gain an in depth understanding of the meanings and definitions of a situation through informants and not measurements (Wainwright, 1997). The qualitative researchers immerse themselves in a context, giving accurate descriptions of phenomena through the participants' own view. Qualitative research aims to understand a research problem or at topic from the perspectives of the local population it involves (Mack, Natasha, Woodsong, Macqueen, Guest, & Namey, 2005).

The three most common qualitative data collection methods are **participant observation**, **in depth interviews** and **focus groups** (Mack, Natasha et al., 2005). The observations (often from film or audio recordings) must be transcribed to text. Transcriptions are when the researcher writes down everything that was recorded either with video or audio. It can also include nonverbal communication, for example laughing, hand gestures or the mode of talking.

Participant observation requires the researcher to engage himself or herself in a setting and take part in- and record the activities of the observed populations (Jackson, Drummond, & Camara, 2007). It is suitable for observing people's natural behavior in non-experimental contexts. The researcher can use field notes, audio recordings, or video recordings to record his/her observations and thoughts. The difference between participant observation and non-participant observation is

that with the former, the researcher takes part in the activities of whom he is observing. In the latter the researcher is simply observing activities as they unfold without interfering in them. A more through explanation of non-participant observation using video will follow later in the chapter.

In depth interviews can be structured, semi structured or non-structured. Structured interviews are when the researcher has prepared a set of questions and asks them in a pre-determined order. Semi structured interviews is when the researcher has prepared some questions but can ask follow up questions and improvise questions if the interview goes in unexpected or interesting directions. Non-structured interviews can go in whatever direction the conversation takes them.

Focus groups are a qualitative method where the researcher conducts group interviews. The groups typically consist of 5 to 12 people. Focus groups rely on group interaction to provide insight into specific topics of discussion. They are guided by a moderator (Jackson et al., 2007). The main strength, and weakness, of focus groups is the possible large amount of group interaction. This can be a strength because of the possibility to cover a large amount of topics in limited time, and a weakness because it can lead to group thinking. It can be perceived as an unnatural social setting (Jackson et al., 2007). Focus groups are efficient at getting a broad overview of the concerns of the group or subgroup that is present (Mack, Natasha et al., 2005).

A qualitative researcher usually prioritizes deep understanding above producing generalizable data. The findings can nevertheless sometimes be extended to people of similar characteristics.

Some qualitative purists do not believe in data generalization because they consider it fruitless to look upon findings without seeing them in context. However, there has been proposed ways of judging the quality of qualitative research.

Strengths and weaknesses of general qualitative research methods are summarized in the table below.

| Strengths | Weaknesses |
|---|--|
| Qualitative research can explore how and why phenomena occur. It can also describe complex phenomena in a natural setting or in rich detail | Qualitative research might not be well suited to test hypothesis or theory. Data analysis and data collection are generally more time consuming than quantitative research |
| It is responsive to local conditions, situations and the needs of stakeholders | It may be more vulnerable to biases |
| It can conduct comparisons and analysis across cases | It may not be well suited for making quantitative predictions |
| It provides understanding and descriptions of the participants own views of the phenomenon in question and needs a limited number of participants | It is limited in producing generalizable results |

Table 4 Strengths and weaknesses of qualitative research

4.3 Mixed methods research

Mixed methods research is using qualitative and quantitative methods in the same study.

Mixed methods and *mixed models* are the two major types of mixed methods research design. *Mixed methods* designs have a qualitative phase and a quantitative phase, which are like mini studies on their own. In order to be called mixed methods, the findings have to get integrated at some point. One of the phases can be dominant, but the researcher can also weigh them equally. One of the phases or mini studies can also influence the direction of the second phase (Johnson & Onwuegbuzie, 2004).

Mixed model designs consist of qualitative or quantitative stages. For example, it can try to answer a qualitative research question with quantitative data collection and quantitative analysis.

Alternatively, it can mix both methods in one stage by for example having a questionnaire with both a quantitative rating scale and open-ended answers (Johnson & Onwuegbuzie, 2004).

| Mix Model and Monomethod designs | | | |
|----------------------------------|------------------------------|--------------------------------|------------------------------|
| Qualitative research question | | Quantitative research question | |
| Qualitative data collection | Quantitative data collection | Qualitative data collection | Quantitative data collection |
| Qualitative analysis | Quantitative analysis | Qualitative analysis | Quantitative analysis |

Table 5 Examples of mixed model and monomethod design (Johnson & Onwuegbuzie, 2004)

Table 5 contains six examples of across stage mixed model designs and two examples of monomethod designs. The combination on the right side and the combination on the left side of the table are monomethod designs. All other combinations of cells are mixed model designs. The designs start with either a qualitative or quantitative research question, and the researcher can use which of the data collection and analysis methods they find convenient. The designs does not mix methods within a stage; one stage only uses either qualitative or quantitative methods (Johnson & Onwuegbuzie, 2004).

Strengths and weaknesses of general mixed model research methods are summarized in the table below (Johnson & Onwuegbuzie, 2004).

| Strengths | Weaknesses |
|---|--|
| The strengths of one method can compensate for the weaknesses of another method | Analysis and data collection are more time consuming |
| Evidence from one method can combine and supplement evidence from another method and create a stronger basis for a conclusion | The researcher must have competence in two very different approaches |
| Numbers can add precision to words, pictures and narratives | Methodologists have not yet worked out every detail |
| Words, pictures and narratives can add meaning to numbers | Mixed methods can be more expensive |

Table 6 Strengths and weaknesses of mixed methods

4.4 Research bias

All studies always have biases in one direction or another. One of the tasks of a researcher is to minimize the biases effect on the research (Shuttleworth, 2009). There is a philosophical difference in the way qualitative and quantitative researches view biases. Quantitative research often aims to eliminate biases while qualitative research acknowledges that the study is biased and takes that into account in the analysis and tries to minimize their effect (Shuttleworth, 2009).

There are many different types of bias. Sampling bias can occur when the participant population in the study introduces an inherent bias. There are two types of sampling bias: **omission bias** and **inclusion bias**. **Omission bias** is when certain groups are excluded from the example, for example if the sample only includes men of a certain age. Then the results cannot be extrapolated to people with different characteristics. **Inclusion bias** is when the participants are chosen for example out of convenience and not because they may be the best sample.

Measurement bias is when the researcher inevitably has an effect on the research for example in observations where people know they are being observed and behave differently because of it.

Response bias is when responders consciously or subconsciously tell the researcher what they think they want to hear (Shuttleworth, 2009).

Nonresponse bias can happen in surveys when a part of the sample are unwilling or unable to respond to the survey, and those who do respond are not representative for those who do not ("Survey Sampling Bias," n.d.).

Voluntary response can occur when respondents who have very strong opinions on the subject matter are overrepresented in the sample and the sample members are self-selected. This kind of bias often happen when surveying controversial topics where a majority of those who don't have strong feelings about it won't respond as often as those who do ("Survey Sampling Bias," n.d.).

4.5 Methods for the current studies

The methods used to collect data in this thesis were mixed model questionnaire and non-participant observation, described in general in the previous chapter and described in detail in the following chapter.

4.5.1 Mix model questionnaire

Questionnaires are research instruments consisting of a series of questions with the intention of gathering useful data from the respondents. The purpose of questionnaires is usually statistical analysis, but not always. Some of the advantages of questionnaires are that they are inexpensive and do not usually require much effort from the researcher compared to verbal or telephone surveys.

An example of a questionnaire based on *within stage mixed model design*, is a questionnaire that combines open-ended questions with grading scale questions. Respondents have to answer in a set format. An open-ended question expects the respondent to verbalize his or hers own answer. A closed ended question is a question where the respondent has to choose between a set of predetermined answers to the question.

One of the problems with questionnaires is that the researchers cannot be sure that the respondent's interpretations of the questions are equal to what the researchers meant to ask. This can lead to respondents answering a different question than the researcher intended. Therefore, it is important that the questions are as clear as possible and that there is minimal room for interpretation. To accomplish this, the questions are sometimes so specific that the information gained may be minimal.

4.5.2 Non participant observation

Non-participant observation is a qualitative data collection method that allows the researcher to observe a situation without directly participating in the observed activities. The researcher records events using such tools as field notes and e.g. video to record thoughts and events so he can give more accurate and detailed descriptions (Liu & Sally, 2010). Non-participant observation gathers a different kind of data than other kinds of observation. It is useful for capturing the dynamics of a participant's interactions and processes over time. It records the meanings that participants give the activities in the study context.

One of the strengths of using video in nonparticipant observation is that the researcher can revisit the research data later (Liu & Sally, 2010). According to Ratcliff the quality and detail of virtually any research observation study can potentially be improved by the use of video (Ratcliff, 2003).

Compared to interviews and other methods, the participants are not self-reporting their actions. There are less filters between the researcher and the researched populations. The researcher studies the interactions between individuals in the studied population and collects first hand evidence.

A substantial challenge is the observer's ability to stay unbiased and not filter what he or she is observing through his or her own beliefs and interpretations. Detailed field notes and thorough analysis make the research less biased. The researcher cannot cover everything in a study, so he or she should make sure to cover as wide an array of activities as possible within the time and resource limits of the study. The researcher also has to make sure to follow ethical guidelines. It is possible that the researcher's voice dominates over the voices of the observed. The researcher can make the study less influenced by his or her biases by interviewing the observed and including their version of what happened as well as the researchers own version (Liu & Sally, 2010).

A study done in 2007 found that observation is a very good method for *usability and documentation research* because observations can spot instances where users utilize ineffective workarounds instead of using functionality in software. Users often experiment to find their own way of doing a task, instead of doing it the way application developers intended it. An example would be to use a physical calculator for calculations instead of using automated functionality in the software. By using workarounds, a user might spend 10 minutes on a task that would normally take 2 minutes to complete. In these instances, the users may think themselves that they are using the software in the most efficient way, or they may suspect there is a more efficient way of doing the tasks and not bothering to seek help to find out. The study also found that users tend to overstate the amount of time they seek help when self-referencing in interviews or questionnaires compared to data recorded from observations (Novick, Elizalde, & Bean, 2007).

4.5.3 Heuristic evaluation

Heuristic evaluation is a usability evaluation method where evaluators use a set of heuristics (recognized usability principles) to identify problems (Wallace, Reid, & Clinciu, 2013). One way to do heuristic evaluation is to have usability experts reviewing an interface and compare it against accepted usability principles (Affairs, 2013). Heuristic evaluation is found to be an extremely cost efficient method of inspecting an interface (Nielsen, 1992). One can use a small set of evaluators and they can have varying degree of expertise (Nielsen, 1992). The evaluators systematically review the interface, checking it for one heuristic at a time. The goal of the evaluation is to find usability problems in an existing design (Nielsen, 1992).

4.6 Data collection

The studies in this thesis used both qualitative and quantitative methods. The quantitative method was a questionnaire and the qualitative method was video observation. The quantitative data collection consisted of a questionnaire targeted at real users of DHIS 2 in Malawi. The qualitative data collection was video observation performed on students in Norway using DHIS 2 as part of a university course. The students were attending an international course about health information systems and they had never used DHIS 2 before.

4.6.1 Questionnaire

In order to gather more data about real world use of DHIS 2 and learn about the perspectives of the people who are working with DHIS 2 daily, a questionnaire was produced and a survey conducted as a part of this thesis. The questionnaire was distributed to every HMIS (Health Management Information System) officer in Malawi. In Malawi, there is one HMIS officer in every health district. There are 29 health districts and the questionnaire was thus sent to 29 HMIS officers. HMIS officers mainly work with data entry, data quality and data analysis in DHIS 2. They receive paper reports from the health facilities and enter the data from paper form into DHIS 2.

The questionnaire was sent by e-mail and the mailing list consisted of 39 emails because some of the HMIS officers had more than one email address. It was thoroughly checked that all the responses came from different people. The mails containing the questionnaire were sent on 12/5/2013.

Reminders were sent out on 12/9/2013, 1/14/2014 and 3/11/2014.

As an extra incentive to reply to the survey, a lottery was conducted by draw choosing a random participant to win a prize of 20.000 Malawian Kwachas (around 48 USD or 314 NOK). The deadline for participation in the lottery was 12/10/2013, but respondents were free to reply to the questionnaire without a deadline.

4.6.2 Non-participant observation using video

There were numerous reasons why video observation of students at UiO, using DHIS 2, was chosen in this thesis. Non-participant observation was used to get qualitative information on usability of the software. The scientific question was: *How is the usability of DHIS 2 for novice users of the system?* It was interesting to assess the usefulness of the online manual for people using DHIS 2 for the first time. Video observation could potentially give valuable information on problem-solving approaches applied when using DHIS 2. It could be assessed if the interface caused confusion among novices.

The video observation was done on students taking the *"Inf 5761 health management information system"* course at the University of Oslo. 23 master students divided in 5 groups took this course. The students were using a DHIS 2 demo version to analyze population health data from Sierra Leone. The assignment was related to giving advice on how to achieve the Millennium Development Goals (MDGs). Students attending the two international Master's programmes *"International Community Health"* and *"Health Economics, Policy and management"* were participants of the course along with students from the *department of informatics* at the University of Oslo. This made the course applicants quite diverse as they got students with health background mixed with informatics students.

The DHIS 2 demo was a fully featured version of DHIS 2 that is freely available online. The demo was the web application version of DHIS and it let users try out and experience the system. The demo version of DHIS 2 featured health data from the year before the current, from Sierra Leone. The server reset the entire DHIS 2 demo to its default state once per day. This meant that anything the users did would be reset so the users could not make any lasting damage to the system. The advantage of this was that users could freely experiment with the system and try out entering health information, change indicators and so on without worrying about causing any lasting consequences.

The University of Oslo supplied the camera used for the observation. The film recording was carried out from 13.30 to around 15.30 on March 4 2013. Some of the recording was done with the camera on a tripod, but mostly it was done while the observant held the camera by hand. The recording took place over 2 days. About 78 minutes of film shots were recorded on March 4th 2013 and about 52 minutes on March 5. In the films, the students in the course were working on their lab assignments and the supervisors of the course were available for assistance. There were 25 students in all divided into five groups.

Before recording started, the research supervisor informed the students of the purpose of the filming and the students were asked for consent. The participants were informed that the video would only be used to analyze the usability of DHIS 2. None of the students had any objections to participate at the onset of the study. During the recording, the students that got assistance were of particular interests, because of the possibility that usability issues were the reason why they needed help. One student objected to being filmed some time after the observations started. When this happened, the observation stopped filming that particular student.

The focus of the observant was problem solving, specifically if they used the online manual, and what alternate approaches they took if they did not use it. Capturing both their screens and external problem-solving activities was important.

CHAPTER 5 EMPIRICAL FINDINGS

The empirical findings from the questionnaire and the video observation (page 55 and page 55) will be presented in this chapter. The results will be interpreted and commented upon as they are presented. Further discussion of the findings can be found in CHAPTER 6.

5.1 Questionnaire surveying Malawian health workers

There are various user groups who use DHIS 2 in Malawi and the HMIS officers work full time with DHIS 2. In each district there are also about 20 programme coordinators. The coordinators' duties involve aggregating, analyzing and reporting of data and they are occasional (casual) users of DHIS 2. Their age, sex and status are varied (personal communication with Jens Kaasbøll). In addition, there are around five clerks in every district who assist with data entry in DHIS 2. The clerks are mostly juniors (personal communication with Jens Johan Kaasbøll). Since HMIS officers are the people who have the most extensive experience with DHIS 2, they were selected for participation in the survey. UiO had contact details for this group and further investigation to get in contact with the participants was unnecessary.

The questionnaire was sent to the HMIS officers in Malawi in late November 2013. The HMIS officer in each of the 29 districts in Malawi was invited to answer the questionnaire (sample size of 29). The officers have the responsibility for data entry in DHIS 2, as well as validation and data analysis.

The response rate was, after several reminders, 59 percent, which is a satisfactory and a fairly high response rate for an online questionnaire.

5.1.1 The respondents

The first questions in the survey were concerning personal information on the participants. The data show that the respondents were mostly men (88%), as 14 of the respondents were males and only two were women (12%). As shown in Table 7, all of the respondents were more than forty years old, and half of them were above fifty. The respondents were mainly working with the data entry modules (88%), data quality modules (88%), and the data analysis (81%) modules of DHIS 2. None of the respondents had less than 7 months experience using DHIS 2 and most of them (88%) had more than a year experience. The majority have worked with DHIS for several years.

| Experience | Number of responders |
|-----------------|----------------------|
| 7 – 12 months | 2 |
| 1 to 2 years | 7 |
| 2 years or more | 7 |
| Age | |
| 41 -50 | 8 |
| Over 50 | 8 |

Table 7 Responders experience with any version of DHIS and the age of responders.

The respondents are not representative for the entire DHIS 2 workforce, but the HMIS officers in Malawi seem to be dominated by senior men. The high age of the participants means that the respondents have not grown up with computer technology. The officers may therefore have faced more challenges learning DHIS 2 than people who have had early access to computers. The clear majority (88%) of male respondents may point to a male dominated work culture at this level of health care work in Malawi.

The data show that the responders were all quite experienced users. Thus, they are far beyond the initial part of their learning curves (Page 35) at the point of the survey. This can be considered positive for the survey as such, as it means that the respondents have enough experience to give a fair assessment of DHIS 2. It also means that the survey does not necessarily give information on the usability of DHIS 2 for novices. Although the respondents have all been novices some time back, they may have had responded differently if they answered the survey at an earlier point of their DHIS 2 career.

5.1.2 DHIS 2 usability, the online manual and the error messages

In order to investigate the responders' view on usability of DHIS 2 and the online manual, the respondents were asked questions designed to give insights in these topics. Questions 1, 2 and 4 in this section were about rating different aspects of DHIS 2 on a scale from one to ten (one meaning very poor and ten very good).

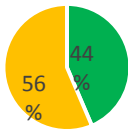
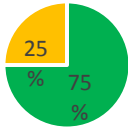
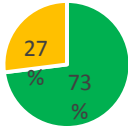
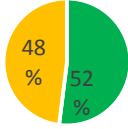
In order to visualize the results described below, the numbers were categorized in three groups and designated different colors. The top of the scale, defined as ratings from eight to ten, was classified as *“very easy/helpful/useful”* and shown in green. The medium part, defined as ratings from five to seven, was classified as *“average easy/helpful/useful”* and shown in yellow. The lower part, defined as ratings from one to four, was classified as *“not easy/helpful/useful”* and shown in red. They are presented in colored pie charts in Table 8.

The first question asked in this section was *“How easy do you find it to use DHIS 2?”*. Thirty-one percent (n=5) of the respondents gave DHIS 2 the highest possible score. Seven responders (44%)

rated eight or above, in the pie chart (table 8) equivalent to “very helpful” (green). The remaining 56% of the respondents (n=7) showed a spread distribution of ratings between five and seven (yellow). The average rating was 7.6 and none of the respondents gave a rating below five.

It is satisfactory that many respondents gave the top ease of use rating and that 44 percent rated the application 8 or above (green). However, the mean value of 7.6 indicates that there is room for improvement of the usability. The fact that 19% (n=3) rated ease of use as low as five shows that some officers have challenges using the program even with extensive experience. There was no correlation between ease of use ratings and respondents experience with the software within the experience range of the respondents. Summarized, the answers show a favorable picture of the usability of DHIS 2, but that there is need for improvement.

Table 8 Questionnaire questions related to usability, illustrated with pie charts

| Question | 5 | 6 | 7 | 8 | 9 | 10 | Average | Pie chart |
|--|------------|------------|------------|------------|-----------|-------------|---------|---|
| Q1. How easy do you find it to use DHIS 2? | 19% (3) | 13% (2) | 25% (4) | 13% (2) | | 31% (5) | 7.6 |  ■ 8 - 10 ■ 5 - 7 |
| Q2. How helpful are the error messages within DHIS 2 to you? | 19% (3) | | 6% (1) | 6% (1) | | 69% (11) | 8.75 |  ■ 8 - 10 ■ 5 - 7 |
| Q4. How useful do you find the online manual of DHIS 2? | 9% (1) | 9% (1) | 9% (1) | 9% (1) | | 64% (7) | 8.6 |  ■ 8 - 10 ■ 5 - 7 |
| Q5. How would you rate overall satisfaction with DHIS 2? | 18% (3) | 12% (2) | 18% (3) | 12% (2) | 6% (1) | 35% (6) | 7.82 |  ■ 8 - 10 ■ 5 - 7 |

Question 2 was *“How helpful are the error messages within DHIS 2 to you?”*. Eleven respondents (69%) gave a rating of 10 to this question. Twelve respondents (75%) rated the error messages 8 or above. Five respondents (25%) rated 5-7 and out of these three officers rated the error messages 5. There were no ratings below 5 and no relation between the ratings of how easy the respondents found DHIS 2 to use (question 1) and how they rated error messages (question 2). The average score on the question was 8.75.

The helpfulness of the error messages of DHIS 2 is the answer with the highest rating. Two thirds of the respondents scored it above eight and 69% gave it a top rating. This is a very noticeable result.

An average of 8.75 shows that the respondents found the error messages *very helpful*. There was no rating below five, while three respondents rated it five. For the medium ratings, it is fair to believe that the content or language of the error messages can be improved to make them more helpful to these respondents. However, it cannot be ruled out that some respondents may rarely get error messages and thus do not find them helpful. The spread in ratings from the responders may also reflect that the error messages can be very good in some parts of the software and not as good in others. People who rated high score may predominantly use the modules with helpful error messages and correspondingly the low ratings may reflect usage of modules with a lower quality of error messages. Summarized, the error messages seem to be very useful for the respondents.

Question 3 in the section was *“Have you realized DHIS 2 has an online manual?”*. Eleven of the respondents reported yes and the last third (n= 5) answered no. Thus, more than 30% of respondents report not knowing about the online manual. This is a high number. This may indicate that it is difficult to locate the help center in DHIS 2. Additionally, use of the manual may not have been properly explained in the training period. There is also a possibility that that usability of the application is so good that many respondents never had a need for an online manual, however the over-all findings do not support this hypothesis.

There is both an online manual integrated in DHIS 2 as named *“Help Center”* and two different manuals that are downloadable as PDF files. It is not known which of these manuals the respondents referred to in the reply. Therefore, it will be assumed that the respondents could have been referring to any of these three manuals.

An interesting observation was that 2 out of the 5 respondents who scored the usefulness of online manual 10, and three respondents who scored it 8, 7 and 5 respectively, did not mention the online manual as a problem-solving approach (Table 10).

Question 4 in this section was *“How useful do you find the online manual of DHIS 2?”*. All of the respondents that stated they knew about the online manual (n= 11) rated its usefulness. None of the

respondents who answered that they were not aware of the online manual (question 3) rated the usefulness of it, which is a good sign for the validity of the questionnaire. Seven (64%) of the responders to this question gave top score on usefulness of the online manual. Eight responders (73%) rated it eight or above (green). 27% of the replies (n= 3) were evenly spread between scores 5-7 (yellow). None of the ratings were below five, and the average score was 8.6.

A possible cause of the variable ratings is that the respondents were in fact rating different manuals. Since they could have been rating any of the three different manuals for DHIS2, which are all available online, it is possible that the quality of the three manuals are uneven. The majority of the respondents gave the highest possible score, which is a good indication that the online manual is useful to the respondents who acknowledged the existence of it. Twenty-seven percent of the respondents rated the online manual between five and seven, which points to it not being very useful for all users and that it has potential for improvements. It is not clear from these replies whether it is the content of the manual or the accessibility of it that can be improved. The accessibility of the online manual will be further discussed on page 76.

5.1.3 Problem solving approaches

The questions related to problem solving approaches were both closed- and open-ended. The open-ended questions gave the respondents the opportunity to express themselves in their own words.

Question 5 was “*How do you approach problem solving?*”. The respondents could choose one or several of the answer options for this question. The distribution of replies is shown in .

| Reply | Responses |
|---|-----------|
| Online manual | 6 |
| Asking someone in the office | 5 |
| Asking someone using email | 10 |
| Asking someone using the built in message functionality of DHIS 2 | 6 |
| Trial & error | 4 |
| Explore the interface and look for a solution | 3 |

Table 9 Distribution of problemsolving approaches

The responses show that the preferred solution to problems was asking someone. 62 percent (n= 21) of all answers (n= 34) were one of the three options that involved asking someone. A good 63% of the respondents (n= 10) reported that they asked someone by e-mail, 38% (n=6) reported asking through the DHIS 2 message functionality and 31% (n=5) reported asking someone in the office. The exploration and trial and error options combined were used by 44% of the respondents. Thirty-eight percent of the 16 respondents (n=6) answered that they used the online manual to solve their problems, but all of these also used other approaches.

E-mail was the most common way of asking someone (n= 10), according to the respondents. Only 38% used the integrated message functionality to contact colleagues to discuss their problem. This may indicate usability flaws in the DHIS 2 messaging function, or at least possibilities for improving this functionality.

| How useful do you find the online manual of DHIS 2? Score | Number of respondents | Listed <i>"online manual"</i> in <i>"how do you approach problem-solving?"</i> |
|---|-----------------------|--|
| 10 | 5 | yes |
| 6 | 1 | yes |
| 10 | 2 | No |
| 8 | 1 | No |
| 7 | 1 | No |
| 5 | 1 | No |

Table 10 Usefulness score on online manual compared to reported use of it

There are no visible patterns on how the responders who did not use the online manual, rated it. As mentioned, it is interesting that two of the respondents who rated it 10, were not using it for problem solving.

On **Question 6**, *"In your opinion, what are the good parts of the DHIS 2 interface"*, the respondents gave various answers. In Table 11 the replies are listed and categorized by keywords. The keyword *"data analysis"* was used with a broad interpretation. It included report generation, validation of data and other functionalities with the end goal of analyzing data.

| | | | | | | |
|-----------|---|-------------------|---------------|--|-----------|---------------|
| no. | Replies | | | Keywords | | |
| 1 | They are very easy to use | | | Usability | | |
| 2 | Available from anywhere for data entry, validation and analysis | | | Accessibility, data entry, data analysis | | |
| 3 | Reporting rate summary | | | Data analysis | | |
| 4 | Report manipulating (pivoting) | | | Data analysis | | |
| 5 | The system allows downloads to excel for further analysis. | | | Data analysis | | |
| 6 | The dashboard, maintenance, services and help menu | | | | | |
| 7 | It was well designed | | | Usability | | |
| 8 | User friendly | | | Usability | | |
| 9 | The pivot tables and data visualizers | | | Data analysis, report generation | | |
| 10 | Easy report generation | | | Data analysis, report generation | | |
| 11 | Appearance of the org units hierarchy, pivot table | | | Data analysis, | | |
| 12 | Real time and that all programme reports are captured in one database | | | Accessibility | | |
| 13 | It is web based | | | Accessibility | | |
| 14 | Data entry, Reports, creating graphs and tabulation | | | Data entry, data analysis, report generation | | |
| 15 | Report generation | | | Data analysis, report generation | | |
| 16 | The dataset report generation and reporting rate summary | | | Data analysis, report generation | | |
| Keywords: | Data entry | Report generation | Data analysis | | Usability | Accessibility |
| Count: | 2 | 5 | 10 | | 3 | 3 |

Table 11 Questionnaire replies about good parts of the DHIS 2 user interface grouped by keywords

As expected for open-ended questions, the answers were diverse. Some of them were specific and some more general. Ten responses highlighted functionality related to data analysis as a favorable asset. Three of these mentioned functionality regarding pivot tables. There were a few noteworthy topics in the replies:

Accessibility: Reply 2, 12 and 13 mentioned the accessibility as a strong point. The database can be accessed from anywhere with an Internet connection, as long as the users have a device with an Internet browser. DHIS 2 is compatible with any device with an Internet browser, regardless of operating system or device. This is a great advantage because it eliminates the need for dedicated software or hardware for access.

Data analysis: Several responders of the questionnaire mentioned data analysis as a strong point. Reply 3 and 16 mentioned reporting rate summary as useful. Reply 5 emphasized the possibility to download reports to Excel to achieve more functionality than in DHIS 2. Reply 4, 9, and 11 mentioned the pivot tables. Reply 9 and 14 mentioned data visualizers and reply 10, 14, and 15

mentioned reports in general. To summarize, many of the answers were emphasizing functionality in data analysis as assets and this points towards the data analysis module of DHIS2 as working well. Data analysis is likely to be what HMIS officers spend most time doing and it is assumed one of their most important work tasks. Therefore, it is a compliment to DHIS 2 that so many of its users mention data analysis as a strong point.

Question 7 was: *“In your opinion, what do you think could be improved in the DHIS 2 interface?”*.

This was also a very open question that gave diverse answers, as expected. Some answers pointed to features that were lacking in DHIS 2, and others were complaints about technical details.

| no. | Replies | | | Keyword | |
|-----------|--|----------------|---------|---|---------------|
| 1 | The explanations on how to make pivot tables I don't really understand them | | | Pivot tables, user manual | |
| 2 | Ability for district supervisors to add new users and their roles | | | User account management, feature | |
| 3 | Switching on or off facilities not offering the service as this usually reporting rates especially MoH (Ministry of Health) facilities | | | Report generation, data analysis, feature, user interface | |
| 4 | To be to import data from other EMR (Electronic Medical Journal) | | | Lack of integration with other systems | |
| 5 | The DHIS 2 is user friendly in my opinion, but in a developing country like Malawi, we are always faced with the problem of internet connectivity. You can stay for days or weeks without accessing DHIS 2 since it is web based | | | Accessibility | |
| 6 | Save option for data entered offline | | | Data entry, feature | |
| 7 | At the moment it is quite okay, more time in need for me discover more areas for improvement, thank you | | | | |
| 8 | It is reasonable for the time being | | | | |
| 9 | Most of them are good but just need advanced training to explore its usability | | | | |
| 10 | The graphical page layout to guide serious data users | | | User interface | |
| 11 | Where ever the field is numeric it should be accepting 02,001 etc. as one not giving error message | | | Data entry | |
| 12 | It has to be user friendly using support visits to users | | | User account management | |
| 13 | Server should not frequently off | | | Accessibility | |
| 14 | Downloading to excel package | | | Data analysis, feature | |
| 15 | Revisiting other reporting forms | | | Data entry, feature | |
| 16 | include an inbuilt pivot table for easy data analysis | | | Data analysis, feature | |
| Keywords: | User account management | User interface | Feature | Data analysis | Accessibility |
| Count: | 2 | 2 | 6 | 3 | 2 |

Table 12 Questionnaire replies about the improvement areas of DHIS 2 grouped with keywords

A general observation was that many of the replies did not answer what was actually asked in the question. Rather the participants requested specific functionalities. For example, three responders asked for specific features that were missing. One of the demanded features was user account management, one was better data sorting functionalities and one was related to pivot tables.

There was no apparent pattern in the replies. The lack of pattern could indicate that there is no particular topic that is generally perceived as troublesome. Another explanation is that the sample

group is not large enough for a pattern to appear. Reply 1 specifically mentioned poor instructions on using the pivot tables. It is reasonable that the person points to the end user manual or the help center, although it is not explicitly written. The responder could refer to any of the manuals.

The most concerning statement in the responses was:

“You can stay for days or weeks without accessing DHIS 2 since it is web based”.

DHIS has functionality to save data entry forms when offline and upload them automatically when connection return, but it lacks an extensive offline functionality. This response emphasizes the need for an offline mode in DHIS 2 and the functionality to synchronize the database with a local hard drive. The next section lists some prevailing themes in the replies to improvement possibilities of DHIS 2:

Missing functionality: Reply 6, 14 and 16 were about needs of functionality that actually exists in DHIS 2. An offline save option, download to excel option and inbuilt pivot table were features demanded by the respondents. These functionalities currently exists in DHIS 2. A possible interpretation of the answers is that the respondents knew about these functionalities, but did not think they were good enough. Another interpretation is that they did not know about the existence of the functionalities, which could be worrying.

Accessibility: Reply 5 and 13 point out that unstable internet functionality and server downtime is something that HMIS officers often have to deal with. These are issues that do not relate to the DHIS 2 software *per se*. Rather they are problems with the web infrastructure that DHIS 2 relies upon.

Some of the replies were difficult to interpret. This highlights one of the limitations of a questionnaire, namely the inability to ask follow-up questions. Importantly, every single respondent would recommend other countries to use DHIS 2. This indicates an overall satisfaction with the software and that the strengths of the software outweigh the weaknesses.

5.2 Video observation of Health Information System course attendants at UiO

The researcher, who was observing and filming students working on assignments using DHIS 2, carried out the video observation. As described on page 55, the students were working in groups of five, using the demo version of DHIS 2. The researcher observed by recording the students on film and analyzing the films subsequently. There was recorded a total of 2:12:35 hours of film.

The students were given assignments on suggesting how to reach the United Nations Millennium Development goals (MDGs). As a basis for this task, they extracted data from the demo version of

DHIS 2 that covers Sierra Leone. The students were observed to be mostly engaged working on their assignments and the frustration levels were not observed to be high. There was no significant frustrations observed regarding navigating in the user interface.

The two supervisors in the lab assignment work were eager to help the students out with the assignments. More than 10 incidents were recorded where supervisors helped students with their assignments. The supervisors were observed to be helping the participants with semantic questions and interpreting findings from the database, but not for user help as such. During the observation, it seemed that one of the preferred problem-solving strategies was group discussion. Trial and error approach was also observed. The participants were observed to mainly be using a combination of trial and error and group discussion to complete their assignments. Consulting the online manual was observed 3 times during the observation. Thus, most of the problem solving was in the context of interpreting data from the database and putting together the assignments. The problems seemed not to be related to the user interphase of the DHIS 2 software.

Below are a few descriptions of typical incidents that occurred during the observation. Many of recorded sequences were very similar and only a few examples will be described.

Example of group problem solving in video 41:

The incident happened in video 34 between 03:09 and 06:20. The group of four students was working in the data visualizer module of DHIS 2. The group was comparing the immunization rate for measles with the reporting rate the data were based on. They noticed that if they only looked at the immunization rate it looked promising regarding meeting the targets for that dataset. Subsequently, they compared the immunization rate to the reporting rate and found that the data the indicators were based on were poor. This could indicate that the immunization rate gave a biased picture, because it was feasible that only the facilities with good results had submitted the reports for that dataset. The group concluded that the data were not reliable due to the poor reporting rate. The group was also discussing how often measles vaccines were given and if children were given this vaccine more than once.

Example of student being helped by supervisor in video 40:

The incident happened in video 34 between 00:00 and 01:23. In this video, the supervisor aided a group of students in understanding the contents of a specific data set report with immunization statistics. The supervisor was explaining and pointing at the screen. The constant buzz of voices in the video made it difficult to pick out individual voices and follow the conversation. However, it was possible to pick up enough information to conclude that they were not discussing usability problems.

This was likely, because they were looking at the same data report the whole time, and they were not interacting with the software.

There was only incident in the video where one could see students using the online manual for an extended amount of time for solving a problem.

Example of online manual use in video 33:

The incident happened in video 33 between 1:10 and 3:30. The context was that a group of 3 students appeared to be confused about the domain area of organization units and decided to consult the online manual. The group spent about twenty seconds navigating to the correct part of the online manual and started reading about the *“organization unit’s hierarchy”* (described on page 28). They appeared to not read the manual in depth, but rather skimmed it for useful information. After about 12 seconds, the group clicked *“organization units”* in the sidebar and started reading about organization units. At this point, the group started to discuss organization units and the fact that users can edit them. The group was quickly browsing around in the *“organization unit”* section in the online manual, while discussing and pointing at the screen. Through using the online manual and discussing with one another the group reached a shared understanding of the domain areas.

To summarize the videos, the online manual was consulted to a low extent and there seemed to be few software usability problems. Most of the problem-solving was concerning interpretation of the data. The students used discussion and exploration as a problem-solving approach and preferred to ask one of the supervisors instead of consulting the manual.

CHAPTER 6 DISCUSSION

Health information systems are used to keep track of the health status of a country and are useful tools for knowledge-based decision-making. In recent years, there has been an increased focus on Health information systems for measuring progress towards the United Nations Millennium Development Goals (MDGs).

DHIS 2 is a database and analysis system for aggregated quantitative health information. DHIS 2 is developed with flexibility in mind, and is meant it be customizable for a wide variety of settings and contexts. Forty-six countries around the world have implemented DHIS 2 and it has a rapidly growing user base which currently counts around 10 000 users. Since many of the countries that use DHIS 2 are third world countries with very limited resources, it is important to minimize the training cost required to use DHIS 2. The system should be as intuitive and easy to use as possible to ensure successful implementation and use of the information system. DHIS 2 has user documentation, which consists of online help and two different user manuals in pdf file format (further descriptions on page 46). The software also offers error messages that are written to guide the users in problem solving. Error messages can therefore be viewed as user documentation.

This thesis aims to investigate the usability of DHIS 2 and the quality and extent of use of the DHIS 2 user documentation. This chapter will discuss two studies in the context of current knowledge on usability and user documentation.

6.1 The study results in relation to the scientific questions

Two studies were conducted to throw light on the scientific questions defined in the research objectives in this thesis. The studies were a survey and an observation study carried out on two different user groups. One user group represented experienced users and the other represented first time users of DHIS 2.

The research objectives were:

1. How is the usability of DHIS 2 for users in Malawi?
2. How are the user manuals of DHIS 2 experienced by users in Malawi
3. How is the overall satisfaction with DHIS 2 among users in Malawi?
4. How is the usability of DHIS 2 for ngpagaovice users of the system?

Objectives 1-3 were covered by the survey of Malawian health workers occupied full time with DHIS 2. Objective 4 was assessed by an observation study on first time users of the software. The

discussion will be centered around the scientific objectives, focusing on results from the two studies, respectively, that shed light on the objectives.

6.1.1 How is the *usability* of DHIS 2 for users in Malawi

Usability is important for the success of DHIS 2 for any user group. However, different aspects of usability have different significance for the different groups. As described in chapter 3.1 there are five main aspects of usability; **learnability**, **efficiency**, **rate of errors**, **memorability** and **subjective satisfaction**. **Learnability** means that the application is intuitive to learn. **Efficiency** means that it helps users achieve higher productivity. **Memorability** is how easy it is to remember the system after one has been away from it for some time. **Error rate** is the amount of errors committed by the user per unit of time. **Subjective satisfaction** refers to how the users subjectively enjoy using the system.

In order to assess the usability for users of DHIS 2 in Malawi, it should be considered which of the five usability aspects that are most vital for Malawian users. HMIS officers are the most experienced user group of DHIS 2 in Malawi and DHIS 2 aims to be an efficient tool to increase their work productivity. Efficiency was hence an important aspect for the experienced full time workers with DHIS 2. Error rate was also important because a low error rate increases the quality of the work. Quality is important for the value of the work that the officers carry out. Learnability, on the other hand, was less important because the HMIS officers are experienced users who keep their jobs for years. Learning is therefore not a large portion of the career for these officers. The participants in the survey had at least 7 months experience with DHIS 2 and many had long experience with DHIS 1.3 from earlier. Memorability was also of less importance for this user group, as the HMIS officers were daily users. It was therefore less likely that they would forget how to use it. Subjective satisfaction was not a very important attribute to this group, because DHIS 2 is above all a tool for work and user enjoyment is then low priority. Hence, the most important usability aspects for experienced users in Malawi were *efficiency* and *error rate*.

The HMIS officers can be viewed in the three dimensions of user experience with a system (described on page 37); computer experience, skills with the system and knowledge of the subject domain. The HMIS officers should be experienced on all three counts. They have long experience with computers as most of them have been using DHIS for years. For the same reason, they are skilled with DHIS 2, which they have used for at least 7 months. This was the second dimension. They should also be experienced with respect to the third dimension, which is knowledge of the subject domain. They are veterans who have been working for many years Malawian Health Sector.

Several of the questions in the survey were relevant for assessing the usability of DHIS 2. The question most relevant to the efficiency aspect of **usability** was *“How easy do you find it to use DHIS 2?”* The average score on the question was 7.6 on a scale from one (very poor) to 10 (very good). More than half of the responders gave a medium score and the rest rated good. This can be considered a medium profile scoring and it was in fact the lowest average rating in the questionnaire. The fact that five responders gave top score and that none rated it below five were positive findings, but altogether the ratings indicate that there is room for improvement in DHIS 2 ease of use. It should also be considered that the user group in the survey consisted of experienced users and represented seniors with respect to DHIS 2. They were, however, aged above 40 and did not have the advantage of growing up with computers. DHIS 2 users in Kerala, India, had very low skill levels with computers and extensive resources were required to train them (Johansen, 2012)

Error messages

The quality of error messages is very relevant to DHIS 2 usability. If error messages are helpful and aid the user in accomplishing the correct procedure, they are expected to decrease user frustration levels. Error messages were rated very well with a mean of 8.75, the best score in the survey. All five aspects of usability could be influenced in a positive manner by helpful error messages: Learnability increases if the message gives a solution to the problem. They also help efficiency if they aid error recovery. They can lower the rate of errors, as the users are less likely to make the same error again. Memorability can be increased by helpful error messages, as they will show up repeatedly when the error is committed. Helpful error messages probably increase subjective satisfaction, because while it is never enjoyable to receive an error message, it is less frustrating to get an informative error message than for example *“error 40553”*. For these reasons and because of the fact that error messages are interfaced based and not something the user actively must seek out, error messages may be the most important user documentation in DHIS 2.

The positive rating of the error messages most likely means that the quality of the messages is considered high and that they are helpful even for experienced users. There are also other interpretations, however, that may have influenced the results. Some respondents may have had in mind that the error messages ensure high quality of the entered data and that this is an important premise for the value of health information. Another possible reason why HMIS officers rated the helpfulness of error messages so high may be that they remember the importance of the error messages when they were at an earlier phase in the learning curve and often committed errors. The diversity of the ratings on how helpful the error messages were could reflect that they are of variable quality in different parts of the software. They may be of very good quality in some parts of

the software, but less good in others and the users may be variably exposed to the different quality error messages.

It is interesting to analyze the researchers attempt to evaluate the error messages using the heuristic evaluation method described on page 54. The next section contains this researchers attempt at doing an heuristic evaluation of whether two error messages from the DHIS 2 application, Error Message 1 (EM1) (Figure 24) and Error Message 2 (EM 2) (Figure 25) adhere to the guidelines for error messages described on page 45. The example error messages were selected through testing.



Figure 24 Error Message 1

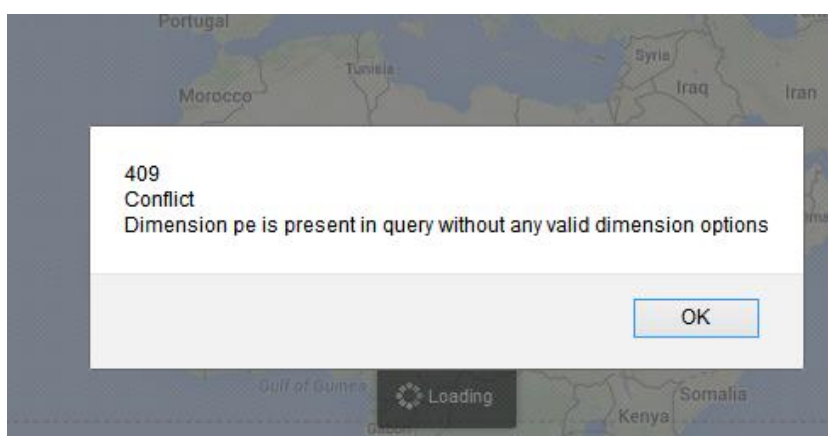


Figure 25 Error Message 2

The *first guideline* is for an error message to be “Explicit”. Error Message 1 (EM 1) tells the user that no series items are selected. This is an explicit error message in that it is clear for the users that

there is an error and that something needs to be done. Error message 2 (EM 2) is also an explicit error message in this respect. If there had been no error message and DHIS 2 still did not respond as expected, it would have been very confusing for a user because they would not have known what was supposed to happen.

The *second guideline* is for the error messages to be “*human readable*”. EM 1 does not contain an error code and the text is readable. EM 2 does not fulfill this guideline very well, as the text contains an error code, an abbreviation and is difficult to understand for most users.

The *third guideline* is about “*politeness*”. EM 1 is neutral in this aspect. It simply tells the user what the problem is, without pointing out that the user has done something wrong. It is a plain message, which does not trigger uncomfortable feelings. EM 2 is less polite in that it takes it for granted that the user knows the applied jargon and it may invoke the feeling of foolishness for not understanding.

The *fourth guideline* is about “*preciseness*”. EM 1 is precise in telling the user what the problem is, but could have been even more precise by using the term “*data series*” instead of “*series items*”. It could also have given more precise instruction on what to do to, although it is obvious that data must be selected. EM 2 may be precise to advanced users, but the text would mean little to most users.

The *fifth guideline* is that the error message should give “*constructive advice*” to the user. While EM 1 is precise and readable, it does not explicitly tell the user what to do. Nevertheless, for the user the solution to the problem is obvious enough. EM 2 does not follow this guideline, as the solution to the problem cannot be read directly from the error message.

Both error messages follow the final guideline, “*visibility*” as they are clearly visible. In summary EM 1 more or less also follows the “*explicit*”, “*polite*”, “*human readable*”, “*precise*” and “*constructive advice*” guideline, while EM 2 does this to a lesser extent. It is only very good for the “*explicit*” and the “*visibility*” guideline. Thus, EM 1 can be considered a better error message than EM2.

While error messages are clearly appreciated by the HMIS officers in Malawi, it can be speculated if helpfulness of the error messages is less or more important for other user groups with less DHIS 2 experience. Programme Coordinators, for example, are more casual users of DHIS 2. For these users error messages may actually be even more helpful, as these users will run into them more often. The same argument can be applied for the office clerks. It is possible, however, that a certain skill level is required to understand the content of the messages and that some messages may be less useful to less experienced users.

General observations

Some general observations that are positive with respect to usability of DHIS 2, are the facts that there were no ratings on any question below five and that all of the respondents would recommend DHIS 2 to be used in other countries. These findings are not compatible with perceived usability below acceptable levels.

Problem-solving approach

The most preferred problem-solving method was asking someone, even for those who rated the manual positively. One reason that respondents were contacting others for problem solving could be the social element of interacting with other people. One noticeable finding is that the most common problem solving approach was contacting a colleague using email, rather than using the messaging functionality integrated in DHIS 2. The fact that more respondents chose e-mail could indicate usability problems with the DHIS 2 messaging functionality. The fact that e-mail is more commonly used than DHIS 2 messages could mean that they prefer e-mail because it is considered more confidential or private. E-mail is also a very reliable technology which has stood the test of time. DHIS 2 messaging may have reliability issues.

Contacting others is not always an efficient way to solve a problem. The response time may be long, there is no guarantee of a satisfying answer, and they are taking up other people's time and energy. However, if certain conditions are met, asking someone can be an efficient problem-solving approach as opposed to users figuring it out on their own. A variant of this is appointing "*super users*", giving highly competent personnel a support function as a part of their job description.

The high reporting rate (92%) of the core data in DHIS 2 (on page 32) is a further indication that the usability of the data entry modules in DHIS 2 is acceptable.

The favorable parts of DHIS 2

The respondents gave quite varied replies when asked about their opinion on the good parts of DHIS 2. Data analysis features were most frequently mentioned, especially the report functionality. Two responders cited good overall usability. This is an important element of DHIS 2 and vital for success of a health information system. This finding is thus worth attention. One respondent was specifically referring to downloading MS Excel files for further analysis in Excel and two emphasized the accessibility of the software from any computer (web-based). As most of the HMIS officers in Malawi do data analysis, it is a positive asset that they report this part to be good.

Improvement points in DHIS 2

There are some noteworthy discussion points in the replies concerning the improvement points of DHIS2:

- Three respondents missed functionality that actually exists in DHIS 2. HMIS officers are the most experienced DHIS 2 users in Malawi and it is not a good sign that they were unaware of vital functions like the offline data save- or the pivot table feature. This can point towards weakness in training, usability or user documentation. A possibility is that the HMIS officers knew that the functionality existed, but found them unsatisfactory. If the offline data save feature in DHIS 2 does not work reliably, this would be a serious issue. However, the over-all results from the survey and observation do not indicate serious problems.
- Two respondents expressed accessibility concerns, specifically unstable Internet connection and server downtime. These are issues that are not related to the DHIS 2 software itself, but rather to the web infrastructure. DHIS 2 is dependent upon Internet connection. The fact that this infrastructure is not reliable highlights the need for the offline functionality of DHIS 2 to be as extensive as possible, so work can be carried without a reliable connection to the main database. Submitting and downloading data must be done when the connection is working.

To summarize, the findings of this study indicate an acceptable usability of DHIS 2 among experienced users, but points towards potential for improvements. The respondents experience the error messages to be especially useful and the study indicates that the satisfaction level is high with the data analysis module.

6.1.2 How are the user manuals of DHIS 2 experienced by users in Malawi

Several questions in the survey were related to the user manuals in DHIS 2. The questions addressing user manuals directly were:

“Have you realized DHIS 2 has an online manual?”

“How useful do you find the online manual of DHIS 2?”

An intriguing finding is that one third the responders answered they were not aware of an online manual. If the finding is representative for other user groups, it indicates that a large fraction of DHIS 2 users may not be aware of the existence of its main user documentation.

The fact that so many respondents did not know about the online manual could point towards it being poorly placed in the user interface. The link to the Help section is placed in the *“Profile”* tab in

the top menu (Figure 21). A more standard placement for a help icon in applications is at the top right of the interface where it is visible at all times. Hence, the placement in DHIS 2 is not very intuitive, and it is possible that more users would have known of its location if it followed standard placement convention. The apparent poor placing of the online manual may not be an isolated incident. It could indicate that there are illogical placements of other user interface elements as well. It is also possible that the online manual was not an integrated part of the training the users received.

The result that many HMIS officers reported not to be aware of the user manual may also partly be explained by other means. The respondents may have interpreted the question in several ways. The term *“online manual”*, used in the survey, was meant to cover all the digital versions of the manual. There are two pdf manuals available for download from the website, in addition to the DHIS 2 help center online help. Some may not have considered the pdf manuals as *“online”*. Thus, it is possible that respondents answering negatively to the question actually knew of- and had downloaded any of the pdf versions. This relates to findings by Novick et al where they found that it was useful to have more detailed choices instead of referring to *“online help”* (Novick et al., 2007). The category *“online help”* in their study could be interpreted in multiple different ways. It could mean using a search engine to try to find solutions, asking at an online forum, finding the manufacturer’s documentation online or use the integrated online help in the software. Thus, the term *“online”* has many interpretations and can easily be misunderstood.

The respondents that were aware of the online manual rated the usefulness positively, with an average score of 8.6. This indicates that the online manual is valuable to many users. One must be aware that the respondents may rate any of the online manuals; the pdf files and the help center manual and that these may differ in value. Still, these are positive findings. On the other hand, question 4, *problem-solving approaches*, showed that only one third of the respondents reported to actually be using the online manual as a problem solving approach. Respondents rating the usefulness of the manual with top score did not report to use it for problem solving. This seems to be in accordance with the findings of Novick and Ward that users rarely use manuals (Novick & Ward, 2006).

Response bias towards rating the usefulness of the online manual too high may have contributed to the high rating. It may also be that people found the manual useful when they opened it, but still preferred other problem solving approaches. The fact that many of the respondents rating the online manual highly did not state that they were using it, may relate to the findings of a study by Novick et al. They found that the participants tended to overestimate the degree to which extent

they asked someone else and underestimate situations when they solved the problem by themselves or gave up.

A problem with the online manual of DHIS 2 is that it scales poorly to different screen resolutions. The “*settings*” table is viewed by default in the sidebar and with some settings, a user has to scroll the screen to discover that the online help covers more than the settings (Figure 26). Some users may not think to scroll because at first glance it may look like the “*settings*” tab is the entire help center. This could be an additional factor for not using the online manual.

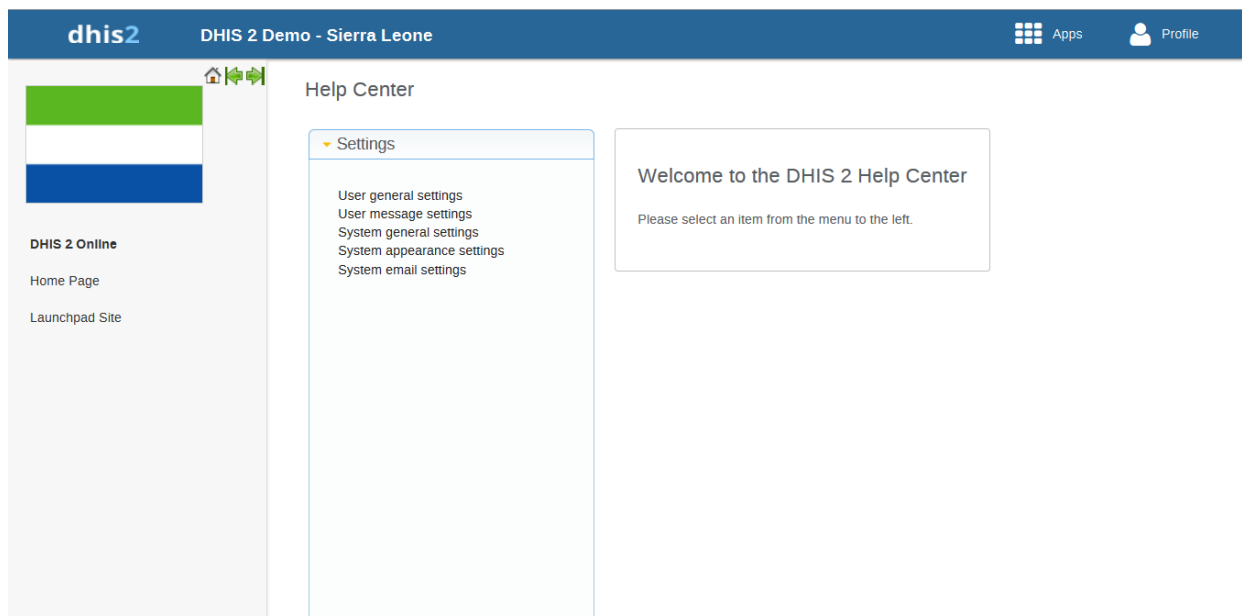


Figure 26 DHIS 2 help center screenshot with 1366 x 768-resolution screen

Furthermore, the “*help center*” of DHIS 2 lacks common navigation features like a search function and may not be easy to navigate for all users. As mentioned earlier (page 44), navigation is something users often struggle with (Novick & Ward, 2006). The way a user navigates the online manual of DHIS 2 is by selecting a category on the left side of the screen. It may be difficult for some users to find the information they need when the online manual is organized sub optimally. A search function could help overcome differences in understanding between the user and the documentation writers who defined the categories (See “*search terms*” page 44).

When the “*help center*” or a pdf manual is viewed, it covers the application on the screen, making it difficult to view both at the same time. In other words, there is a “*Screen real estate*” problem that is described earlier in this thesis (page 44) (Novick & Ward, 2006).

One of the respondents of the questionnaire replied, when asked about areas of improvements for DHIS 2, that the Pivot table module was poorly explained in the manual. This can point toward the language in the manual not being written at the right level of explanation for the reader. As

mentioned on page 44, users sometimes complain that explanations are too basic or too difficultly explained. The reply may indicate that this is true for the DHIS 2 manuals as well. For software like DHIS 2 with users of all skill levels, it is of course difficult for documentation writers to satisfy both amateurs and experienced users. However, when an HMIS officer, who is among the most experienced users in Malawi, has problems understanding the explanation in the manual, it indicates that the level of explanation may be too advanced.

DHIS 2 interacts with a number of other systems, for example a web browser, the java framework and web servers. If there is a problem with any of the other systems, the DHIS 2 manuals are unlikely to help. Sometimes the “*boundaries*” between the interacting systems can be unclear, leading to the “*uncertain boundaries*” complain addressed on page 44.

It is possible some users of DHIS 2 use search engines as an aid for problem-solving, like referenced earlier, at page 78 (Welty, 2011). The survey did not have this option and does not give clues to the use of this problem solving approach. However, it is not likely this is done to a large extent. DHIS 2 has a limited user base and search engines would not find much unofficial user documentation. However, there is substantial information on the domain area online, for example on what an abbreviation (for example ANC1) or a specific indicator used in DHIS 2 means.

A general weakness of self-reflective reports in research is that people are vulnerable to biases and selective memory. People are more likely to remember the usability problems that frustrates them more than other problems that might be more common (Novick et al., 2007).

As a summary, one can say the manuals of DHIS 2 were very useful tools for some users. A large portion of the surveyed HMIS officers (one third) did not know that an online manual existed. Only one third of the respondents reported to use the online manual for problem solving. This indicates flaws in the online user manual and a considerable potential for improvement. Flaws were connected to navigation, search terms, level of explanation, screen real estate and uncertain boundaries, in accordance with complaints on manuals found by Novicks (Novick & Ward, 2006).

6.1.3 How is the *over-all satisfaction* with DHIS 2 among users in Malawi

In the survey, the respondents were asked to rate their overall satisfaction of DHIS 2. To summarize the overall satisfaction among HMIS officers in Malawi the average rating was 8.6 and nobody rated it below five. This must be considered a positive profile and especially 35% respondents rating 10 is remarkable. All the aspects discussed so far affect overall satisfaction. The findings indicate overall satisfaction is good, but there are areas of improvements as 48% of the respondents’ rate it between five and seven.

6.1.4 How is the *usability* of DHIS 2 for novice users of the system

The study that was done with novice users of the system, was a nonparticipant observation conducted on students at UiO. This user group was very different from the HMIS officers, as it represented novices on DHIS 2. Some were master degree students from the Department of Informatics and some were from health science. The students were included in the study to get an impression of the usability of DHIS 2 for first time users and they were a relevant group for assessing how intuitive the interface of the software was.

The most important usability aspect for these users was **learnability**, because they had to find and learn the relevant parts of the software quickly to proceed to their assignments in the short time frame of the course. A low **error rate** was also of importance, because it was essential for students to extract and use the correct and relevant data for their assignments. For this user group users' **efficiency**, on the other hand, may have been less important than for the HMIS officers. The students did not have large quantities of work that was critical to do on time and had less need for efficient, or smart, working. Thus, to reach a high level on the learning curve was not an aim, but rather to reach the level necessary for solving the task adequately. **Subjective satisfaction** would not be very important for novice users, because DHIS 2 is not an entertainment product where user enjoyment is in focus. Hence, the most important usability aspects for novice DHIS 2 users were *learnability* and *error rate*.

The observation study indicated good **learnability** of DHIS 2. In the analysis of the video observation, I specifically looked for problem-solving behavior and use of the user documentation. The major parts of the recordings showed the students engaged in activities related to interpretation of data and not with software as such. The students had a minimum of introduction to the use of DHIS 2 and this indicates good learnability of the software.

The findings that contributed in answering the research question were the counts of how much the user documentation was used and assessments of the general frustration levels of the observed group. The analysis of what kinds of problems they had and how they worked out the problems also added knowledge about the usability of DHIS 2 to the group being studied. The findings of this study further indicated that the use of documentation was low among master students using DHIS 2. The students were observed to be engaged in group-discussion or take trial and error approaches to problem solving. The frustration levels seemed to be low and usability related problems were scarce.

A study from 2011 concluded that the participants were more likely to consult search engines, like Google, than online help (Welty, 2011). This study was also conducted on university students. If the findings were transferable it could be expected that the observed students in the observation used

search engines to find information instead of looking at the DHIS documentation. This was not observed in the recordings. It cannot be ruled out, however, that this took place without being captured on the films. These findings indicate good learnability of DHIS 2 for the user group tested.

6.2 Limitation of the studies

6.2.1 Samples of the studies and caution on generalization

HMIS officers are the most experienced users in Malawi. They measure high on all three aspects of user experienced explained on page 37 (Nielsen, 1994). There are several groups using DHIS 2 in Malawi. Some have been mentioned earlier in the thesis and include the 29 HMIS officers (one in each district), around 20 coordinators and a handful of office clerks in each district. The group that uses DHIS 2 most extensively in Malawi is the HMIS officers.

The most experienced users are obviously not representative for most users of DHIS 2. The respondents in the survey were predominantly men at the age above 40. Many users of DHIS 2 are younger men and women who use DHIS 2 various degrees. The survey therefore gives a picture of usability of the software for older experienced users who work daily with the application. It is not justified to generalize the findings to younger, casual users of DHIS 2.

The observation study was carried out on a user group with other characteristics. The sample was master students at UiO. They were first-time users of DHIS 2. This group may be representative for young and well-educated people who are heavy users of computers. This user group could assess usability of an application, particularly how intuitive the interface is. However, they would not be representative for common users in Malawi.

The users' background, as well as the context, were very different from what they would be in a country that has implemented or will implement DHIS 2. The students at the University of Oslo (UiO) were doing academic assignments. The most relevant users in developing countries are people with lower education and limited experience with computer technology, in a country with less infrastructures to give them basic skills. This would give the relevant users a quite different foundation than the user group in this study. The transferability of findings between a study on highly educated youth and HMIS officers in Malawi must thus be considered poor. The study can, however, be interpreted in means of how intuitive the interface is perceived.

6.2.2 Possible bias

In all studies of social phenomena, biases are inevitable. Especially qualitative methods are vulnerable to bias. The researcher must carefully identify possible biases and consider them. This section will investigate possible inaccuracies in the findings of the studies in this thesis.

The mean values of the ratings in **the survey** were all above 7.5. There were no values below five and 31% - 64% of the ratings were the highest possible rating. It is possible that responders to the questionnaire paint an unrealistic positive picture of DHIS 2. As indicated by Novick et al users tend to underestimate the true frustration levels and time lost when using computer applications when self-evaluating in interviews and questionnaires (Novick et al., 2007). In Novicks study, users were asked to estimate time spent on different activities, which was different from the questions in the survey in this thesis. Novick et al. also found some evidence that participants often overestimate how often they use online help when asked, compared to how often they were observed to use it in observations (Novick et al., 2007). Similar phenomena may have biased answers in the survey towards positive answers. There are also other possibilities for bias in the survey answers.

Response bias (explained on page 52) possibly affected the findings in the survey. A motivating factor for response bias might have been that UiO is one of the financial benefactors of the DHIS 2 project in Malawi, and many of the HMIS officers have met and worked with UiO personnel. Hence, this questionnaire coming from UiO may have motivated them to give a favorable picture of DHIS 2 use in order to get more funding. An other feasible explanation for the large numbers of top ratings could be that the respondents were embarrassed to admit they struggle with different issues.

Nonresponse bias (described on page 52) could have influenced the questionnaire findings because the respondents who did not reply to the questionnaire might have differed to those who did respond. *Voluntary response bias* (explained on page 52) could also have influenced the findings as some respondents may have responded because they had particularly strong feelings about the subject. If there is voluntary response bias in the questionnaire findings, it is from the very positive replies, as no replies were very negative.

Video observation is vulnerable to multiple types of biases. In social research it is easy for the researcher to get attached to a certain viewpoint and subconsciously let that viewpoint compromise impartiality (Shuttleworth, 2009).

There was deliberate bias in the recordings towards recording the groups that were solving problems, as this was the focus of the study. This could have led to over-representation of problem-solving instances in the films. This bias would strengthen the conclusion that usability problems were at a low level for the user group.

Measurement bias (explained on page 52) could have influenced the findings of the observation because of the observation itself might have influenced the participants behavior.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

This chapter will first summarize the conclusions of the thesis, then outline this researcher's advice for the software developers of DHIS 2 and conclude with suggestions for possible research that can further address the usability and documentation of DHIS 2.

7.1 Conclusions

The four research-questions this thesis aims to answer are:

1. How is the usability of DHIS 2 for users in Malawi
2. How are the user manuals of DHIS 2 experienced by users in Malawi
3. How is the over-all satisfaction with DHIS 2 among users in Malawi
4. How is the usability of DHIS 2 for novice users of the system

To summarize the findings, usability of DHIS 2 is considered good among experienced users in Malawi. The survey indicates that particularly the very high rating of the helpfulness of error messages may improve all aspects of usability.

It should be noted that the survey and the observation studies were both done on user groups not necessarily representative for most users of DHIS 2.

Experienced users in Malawi consider the over-all usability of DHIS 2 as good. Still, the ratings of ease of use were the lowest in the questionnaire. They held a medium profile and this indicates room for improvement in DHIS 2 for better outcome in efficiency. It was found that users generally prefer asking someone by email over using the DHIS 2 messaging functionality. This may indicate usability problems in DHIS 2 messaging. When asked about the good parts of DHIS 2, most of the replies mentioned functionality related to data analysis, specifically report generation. This shows that experienced users seemed to be satisfied with the efficiency and error rate of these modules. The qualitative replies, when asked about areas of improvements, suggested that DHIS 2 needs more offline functionality. They also indicated that users were not aware of existing functionality in DHIS 2, which can point towards learnability problems in the software.

Usefulness of error messages is the highest rated element in the questionnaire data, indicating they are indeed very useful. Some medium ratings can indicate that error messages are variable in quality; examples were also found that confirmed this. Error messages may be more important for less experienced users because they run into them more often, but it is also possible that less experienced users have more trouble understanding the content of error messages.

One third of the surveyed users did not know there were online manuals in DHIS 2. This may indicate poor visibility of the online manual and that the links to the manual are not well placed in the interface. Only half of the users that knew about any of the manuals reported that they actually used online manual for problem solving. This shows that most users in the study do not prefer manuals for problem solving. Judged by the users who report to use the online manual, it is considered very valuable. As a summary, the survey indicates that the manual is very valuable to some users, but there is clearly room for improvement to make it useful most users.

When the respondents were asked about over-all satisfaction of DHIS 2, they indicated that it is very good. Both the usability of the system and the quality of the manuals and error messages are important to overall satisfaction. All the respondents would recommend DHIS 2 to other countries, which also indicate high satisfaction.

The observation study shows that first-time DHIS 2 users had few software related problems. This indicates that the interface is intuitive and thus is easily learnable. However, the observation study was conducted on university students using DHIS 2 for the first time, so the findings are not transferable to users in Malawi.

The study conducted in this thesis may be subject to bias.

The main conclusions in the presented studies are

- *The usability of DHIS 2 is considered good by HMIS officers in Malawi*
- *The Error messages are pointed out as particularly helpful by the same user group*
- *The Online manual is not known to a considerable fraction of the Malawian HMIS officers*
- *The Online manual is not used for problem solving by a large fraction of Malawian HMIS officers*
- *The Online manual is considered very useful by the Malawian HMIS officers who use it*
- *The over-all satisfaction with DHIS 2 is good for this user group*
- *All the participating HMIS officers from Malawi would recommend the use of DHIS 2 to other countries*
- *Master students at UiO who are first-time users have few software-related problems using DHIS 2*

7.2 Implications for practice

The implications of this study for the software developers of DHIS 2 are that there are flaws in the user interface and the error messages. Below are listed some specific recommendations from this research.

- The link to the online manual of DHIS 2 should be placed in the right corner of the interface and be visible at all times. Both manuals and the “*help center*” should be linked to at this location.
- All error messages in the software should adhere to the principles of Nielsen (Nielsen, 2001).
- The documentation team should consider focusing most of their efforts on writing interface-based documentation. The interface-based documentation should contain links to other, more detailed documentation. Error messages and balloon help are specifically recommended as a focus.
- The “*help center*” should be easier to navigate and have search functionality.
- The efficiency of the messaging functionality of DHIS 2 should be evaluated
- An online discussion forum where users can discuss use of DHIS 2 and create threads about use of the program would be a useful tool to search for help. These discussion groups should have search functionality so users easily can look up if anyone in the past has had the same problem as they did and started a thread about it. There can be a forum for global DHIS 2 use and forums for specific countries and user groups. It could be wise to let users create anonymous usernames for this forum, in order to lower the psychological barrier users can have against asking for help or voicing their opinions.
- A DHIS 2 offline mode with the ability to synchronize the local machine with the server when online and have all the functionality available in offline mode would be a useful measure to minimize the negative effects of unstable connectivity.

7.3 Implications for further research

This study indicates importance of error messages as user documentation to increase usability of DHIS 2. Error messages are only covered by one single question in the survey and the rating of them was surprising. Even though the finding supports other evidence that interfaced based help functionality is more expedient than user manuals, it should be explored further why error messages seem so useful and if this also is the case for other user groups.

The objective of the observation study in this thesis was to assess usability for first-time DHIS 2 users. This researcher’s advice would be to expand on the findings of current study and design an

observation study that focuses on the relevant user-groups in a country that has implemented DHIS 2, not necessarily Malawi but can be. By observing the most relevant users, one would capture closer to an unbiased view of how the usability really is for the real-world users. One of the strengths of observation as opposed to self-referential methodologies like interviews and surveys is that it can pick up workarounds that users do because they are unaware of the relevant functionality. This would give a more precise picture on how the usability could be improved to increase efficiency.

By questioning and observing actual users of the software at their workplace, we can learn about how the software functions for different user groups and gain a deeper understanding of the usability and usefulness of documentation of actual users. This knowledge can benefit the software developers in making DHIS 2 an even better tool.

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APPENDIX

Appendix A: Mail with the questionnaire invite and reminders

This is the original message that was distributed:

Dear Ms/Mr,

I am Herman Parmo, student at the University of Oslo. I am conducting a survey on the quality of the DHIS 2 online help manual. Please set aside 2 minutes and fill in this questionnaire, [LINK](#). Your feedback will be used to further enhance the help functionality of DHIS 2. The answers will be anonymous.

There will be a lottery between the responders and if you reply, you will have a chance to win 1000 Kwacha. The deadline is 10th of December.

Please feel free to add any additional remarks to my survey, or leave blank if you have trouble answering certain questions.

Thank you very much in advanced for your cooperation.

Sincerely,

Herman Ludt Parmo

The following text of a reminder was distributed at a later stage:

Please remember to respond to the questionnaire. The reward in the lottery that will be conducted on the 10th of December has now been increased to 20 000 kwachas. You could be the winner! Thanks a lot for responding.

Today is your last chance to enter the lottery.

In addition, a last reminder was distributed as follows:

Hi everyone. Tomorrow at 20.00, I will randomly draw one of your names in the lottery. The price of 20000 kwachas will be distributed via my supervisor Jens Kaasbøll which is currently in Malawi. If you respond before this, you will have a chance to win the price.

Thank you for your participation

Appendix B: The questionnaire

The questions and the choices in the questionnaire were defined as follows:

- Please check off your normal assignments in DHIS 2?
 - Data entry
 - data quality
 - data analysis
 - other
- How long have you been using DHIS 2?
 - 0-6 months
 - 7 – 12 months
 - 1 to 2 years
 - 2 years or more
- What is your gender?
 - Male
 - Female
- What is your age (years)?
 - 18 – 25
 - 26 – 40
 - 41 – 50
 - Over 50
- How easy do you find it to use DHIS 2?
 - Rating scale from “very difficult” (1) to “very easy” (10)
- How helpful are the error messages within DHIS 2 to you?
 - Rating scale from “not helpful” (1) to very helpful (10)
- Have you realized DHIS 2 has an online manual?
 - Yes
 - No
- How useful do you find the online manual of DHIS 2?
 - Rating scale from “Not useful” (1) to “Very useful” (10)
- How do you approach problem solving?
 - Online manual
 - Asking someone in the office
 - Asking someone using email

- Asking someone using the built in message functionality of DHIS 2”
- Trial & error
- Explore the interface and look for a solution
- Other
- In your opinion what are the good parts of the DHIS 2 user interface?
 - Open ended response
- In your opinion, what do you think could be improved in the DHIS 2 user interface?
 - Open ended response
- How would you rate your overall satisfaction with DHIS 2?
 - Rating scale from “Not satisfied” (1) to “Very satisfied” (10)
- Would you recommend other countries to be using DHIS?
 - Yes
 - No

Appendix C: Questionnaire results

1. Please check off your normal assignments in DHIS2.

| Replies | N | % |
|----------------|----------|----------|
| Data entry | 14 | 82.4 % |
| Data quality | 14 | 82.4 % |
| Data analysis | 13 | 76.5 % |
| Other | 7 | 41.2 % |

2. How long have you been using DHIS1 or 2?

| Replies | N | % |
|-----------------|----------|----------|
| 0 - 6 months | 0 | 0.0 % |
| 7 - 12 months | 2 | 12.5 % |
| 1 to 2 years | 7 | 43.8 % |
| 2 years or more | 7 | 43.8 % |

3. What is your gender?

| Replies | N | % |
|----------------|----------|----------|
| Male | 14 | 87.5 % |
| Female | 2 | 12.5 % |

4. What is your age (years)?

| Replies | N | % |
|----------------|----------|----------|
| 18 - 25 | 0 | 0.0 % |
| 26 - 40 | 0 | 0.0 % |
| 41 - 50 | 8 | 50.0 % |

| | | |
|---------|---|--------|
| Over 50 | 8 | 50.0 % |
|---------|---|--------|

5. How easy do you find it to use DHIS2?

| Replies | N | % |
|--------------------|---|--------|
| 1 (Very difficult) | 0 | 0.0 % |
| 2 | 0 | 0.0 % |
| 3 | 0 | 0.0 % |
| 4 | 0 | 0.0 % |
| 5 (intermediate) | 3 | 18.8 % |
| 6 | 2 | 12.5 % |
| 7 | 4 | 25.0 % |
| 8 | 2 | 12.5 % |
| 9 | 0 | 0.0 % |
| 10 (Very easy) | 5 | 31.2 % |

6. How helpful are the error messages within DHIS2 to you?

| Replies | N | % |
|-------------------|----|--------|
| 1 (Not helpful) | 0 | 0.0 % |
| 2 | 0 | 0.0 % |
| 3 | 0 | 0.0 % |
| 4 | 0 | 0.0 % |
| 5 (intermediate) | 3 | 18.8 % |
| 6 | 0 | 0.0 % |
| 7 | 1 | 6.2 % |
| 8 | 1 | 6.2 % |
| 9 | 0 | 0.0 % |
| 10 (Very helpful) | 11 | 68.8 % |

7. Have you realized DHIS2 has an online manual?

| Replies | N | % |
|-------------------------|----|--------|
| Yes | 11 | 68.8 % |
| No (Skip to question 9) | 5 | 31.2 % |

8. How useful do you find the online manual of DHIS2?

| Replies | N | % |
|------------------|---|--------|
| 1 (Not useful) | 0 | 0.0 % |
| 2 | 0 | 0.0 % |
| 3 | 0 | 0.0 % |
| 4 | 0 | 0.0 % |
| 5 (Intermediate) | 1 | 9.1 % |
| 6 | 1 | 9.1 % |
| 7 | 1 | 9.1 % |
| 8 | 1 | 9.1 % |
| 9 | 0 | 0.0 % |
| 10 (Very useful) | 7 | 63.6 % |

How do you approach problemsolving?

| Svar | Antall | Prosent |
|------|--------|---------|
|------|--------|---------|

| | | |
|---|----|--------|
| Online manual | 6 | 37.5 % |
| Asking someone in the office | 5 | 31.3% |
| Asking someone using e mail | 10 | 63.0 % |
| Asking someone using the built in message functionality of DHIS2? | 6 | 38.5% |
| Trial & error | 4 | 25.0% |
| Explore the interface and look for a solution | 3 | 18.8% |
| Other | 0 | 0.0 % |

10. In your opinion what are the good parts of the DHIS2 user interface?

- They are very easy to use.
- Available from anywhere for data entry, validation, and analysis
- Reporting rate summary
- Report manipulating (Pivoting)
- The system allows downloads to Excel for further analysis
- The dashboard, Maintenance, Services and Help menu
- It was well designed
- User friendly
- The pivot tables and data visualizers
- Easy report generation
- Appearance of the org units hierarchy, pivot table
- Real time and that all programme reports are captured in one database
- It is web based
- Data entry, Reports, creating graphs and tabulation
- Report generation
- the dataset report generation and reporting rate summary

11. In your opinion what do you think could be improved in the DHIS2 user interface?

- the explanations on how to make pivot tables I don't really understand them.
- ability for district supervisors to add new users and their roles
- Switching on or off facilities not offering the service as this usually reporting rates especially MoH facilities
- To be able to import data from other EMR
- The DHIS2 is user friendly in my opinion, but in a developing country like Malawi, we are always faced with the problem of internet connectivity. You can stay for days or weeks without accessing DHIS2 since it is web based.
- Save option for data entered offline
- At the moment it is quite okay, more time is needed for me to discover more areas for improvement, thank you.
- It is reasonable for the time being
- Most of them are good but just need advanced training to explore its usability
- The graphical page layout to guide serious data users
- wherever the field is numeric it should be accepting 02,001 etc as one not giving error message
- It has to be user friendly using support visits to users
- Server should not frequently off
- Downloading to excel package
- Revisiting other reporting forms
- include an inbuilt pivot table for easy data analysis

12. How would you rate your overall satisfaction with DHIS2?

| Repies | N | % |
|---------------------|----------|----------|
| 1 (Not satisfied) | 0 | 0.0 % |
| 2 | 0 | 0.0 % |
| 3 | 0 | 0.0 % |
| 4 | 0 | 0.0 % |
| 5 (Intermediate) | 3 | 17.6 % |
| 6 | 2 | 11.8 % |
| 7 | 3 | 17.6 % |
| 8 | 2 | 11.8 % |
| 9 | 1 | 5.9% |
| 10 (Very satisfied) | 6 | 35.3 % |

13. Would you recommend other countries to be using DHIS2?

| Replies | N | % |
|----------------|----------|----------|
| Yes | 17 | 100.0 % |
| No | 0 | 0.0 % |